Let me say that, in introducing Bassam Shakhashiri, that I think that we are extremely fortunate to have him in charge of science education. If you remember Viki's talk with the charts, it showed the National Science Foundation as sort of starting out at 40 percent of its budget, and now down to eight percent of its budget. That eight percent isn't much, but it's a powerful -- it's something. And that something is in good hands, as you'll see when I introduce Dr. Shakhashiri, who will encourage us with a few words.

(Applause)

DR. SHAKHASHIRI: Thank you very much. I'd like to start by making a couple of very serious comments, and then I'll get to the level -- try to get to Leon's level. I know I won't succeed.

But I do want to start by telling you about the three biggest lies in the world. You know what they are. The first one is "the check is in the mail." And I see some of you recognize that one. The second one is, "of course I'll love you in the morning." A few recognize this one. And the third one is, "I'm from Washington; I'm here to help you."

(Laughter)

I especially would like to dedicate the next set of statements to Professor Lederman. Because he's not letting me get to what I really want to say.

You can all see what I have in my right hand here. I have a match. If I take this match and I drop it, it falls to the floor. That's physics, Leon.

If I take the match and strike it, that's chemistry. Chemistry is more striking than physics. And physics is no match for chemistry.

DR. JACK WILSON: That really burns us up.

DR. SHAKHASHIRI: Jack has heard this before, and for six months he's been trying to think of a clever response.

(Applause)

I wouldn't say that was a hot retort.

PARTICIPANT: Retort is chemistry.

DR. SHAKHASHIRI: I have to confess to you that I thought very hard about using that example, especially with this audience, but some of the words of Professor Lederman prompted me to be perhaps somewhat foolish and use it.

The last time I had occasion to be on the same platform with Professor Lederman was last October, when the 1985 presidential awardees in science and mathematics were being honored at the State Department Diplomatic Functions Dining Room. And the main speaker

that evening was Professor Lederman. But he was somewhat at a loss in terms of how he wanted to give his talk, because, except for the President and for the Secretary of State, slide projection equipment cannot be used in that room. And so he told me privately afterwards that he'd get back at me some day for not making better arrangements for him to get a slide projector. And so, tonight, I am being punished, because I do have some important things I'd like to tell you, and I have my slides but there's no projector.

It is really a great privilege for me to be here tonight, especially when Professor Weisskopf is being awarded the Medal of the International Committee on Physics Education. And I speak to you as a fellow teacher, although I am a chemistry teacher. And with your permission, I would like to just share with you and everyone else tonight a few important convictions that I have about good teachers. I believe <u>good</u> teachers have four important characteristics which distinguish them from all other teachers. Good teachers are:

Competent in their disciplines

Committed to their disciplines <u>and</u> to the profession of teaching

Comfortable with the methods and techniques they use

Compassionate with students (and colleagues)

The first characteristic is so obvious that I am often questioned about including it. I insist on including it for it is not sufficient for a teacher to be certified as a holder of a degree in a scientific discipline or be tenured at a school or at a college or a university in order to be considered competent. All of us have to maintain our competence by engaging in scholarly and professional renewal activities to keep us ahead of our students and at a level of knowledge much more advanced that what is in the textbooks and manuals we use in our courses. Furthermore, if we are competent in a scientific discipline, say physics, then we must be committed to physics. But commitment to physics alone is not sufficient; we have to be committed to teaching physics as well. Many researchers, of course, are committed to their sub-discipline, but they cannot be characterized as good teachers unless they are committed to communicating physics to those outside their area of sub-specialty. They may be good at research; and if they are, that does not automatically make them good teachers[1]. In my opinion good teachers must be comfortable with the methods they use be they audiovisual aids, lecture demonstrations, computers, books and manuals, etc. As we adapt or even adopt a "new" method or

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[1] In this connection, I am bothered when I hear about some faculty bragging that they do not have to teach (in some instances I suppose I should be happy they are not being inflicted on students); and I am saddened when I hear faculty and administrators talk about "research opportunities and teaching loads" --what a remarkable statement about the value system of some of our institutions of higher education!

technique we often experience discomfort to varying degree. This discomfort has to disappear, otherwise, we should abandon that particular method in order not to diminish our effectiveness as teachers. We must be careful in not becoming too comfortable and thus quickly risking becoming complacent. In addition, I believe we must be compassionate with our students -- we must <u>care</u> about them and about what and how they learn. This should not be done by comprising standards; on the contrary, we should set our standards high. Since our purpose as educators is to enable students to develop fuller intellectual capabilities and emotional capacities while they are under our influence, we and others should recognize that their grades are not by no means the only measure of our success as teachers or their success as students. As good teachers we must also be compassionate with all our colleagues in the educational enterprise including fellow teachers, administrators, and support staff. This will contribute to creating and maintaining an atmosphere conducive to good teaching.

I would like to share with you another strong conviction. Again, both as a teacher and as a person who has a responsibility in the nation's capital. I do firmly believe that the United States now faces a situation by far more critical and more consequential than what the country faced in the immediate post-Sputnik era. There are at least three reasons for this:

1. We have more people living in this country now than we did 25 years ago or so. The population of the United States has increased by approximately 50 million people. To put that number in perspective, that is roughly the population of Great Britain alone. What does that mean? There are more students to teach and we need more qualified teachers to teach them.

2. Secondly, we need to have a good supply of scientists, engineers, and technologists coming through our educational systems in order for our society to continue to enjoy the benefits of technology. That is essentially what the National Science Foundation set out to do in the immediate post-Sputnik era. Now, we need to maintain having a good supply of scientists, engineers, and technologists for economic and national security reasons and in order to retain our international pre-eminence in science and technology.

3. The third reason, perhaps the most important and most consequential of all, is that we now live in a more advanced technological society than we did 25 years ago or so. And it is the education of the non-scientists, the nonengineers, the nontechnologists in

science, in engineering, and in technology that require our attention.

I submit that our greatest challenge now is to extend learning opportunities so that all individuals can continue to expand their knowledge and understanding of science. Improving science teaching is crucial, but it is not enough. Our adult population also needs to learn new science concepts. We need not only skilled scientists, engineers, and technicians, but managers and decision-makers who understand the nature and implications of their fields. And we need a citizenry that can follow and weigh the progress and implications of science and technology. That is why we must be creative and inventive in communicating the very essence of our science and its results to all segments of our society.

Professor Weisskopf said it much more eloquently than I can say it tonight. It is extremely important that we, who care about science, we, who care about science education, very quickly develop effective methods of communicating our science to the non-scientist. We have to do this. We must do this. We all know that scientist are fairly good at communicating science to each other through professional meetings, scientific publications, and a variety of forums. But frankly, we do a poor job communicating science to the non-scientist. It is absolutely crucial that we -- we, the people who know science, we who are competent in our disciplines, we who are committed to our disciplines and to the

profession of teaching quickly develop effective ways of communicating science to the non-specialist. And the plea that Professor Weisskopf has made tonight -- and not only tonight; he's been saying it over and over again -- we must reach our students, both in the formal classroom setting and in the informal classroom setting. Most people most of the time learn most of what they know outside of the classroom. Our responsibility in the classroom is to enable them to appreciate the process of science, the way in which science functions, the way in which it works. So we have an awesome responsibility as teachers.

Also, we have to try to make sure that the quality of science that is taught in our pre-collegiate classes, in our undergraduate classes, is based on laboratory experience. There is a move afoot in this country to eliminate laboratory work from pre-collegiate programs and from introductory undergraduate courses. Most of the reasons that are given are based on economics. If we feel strongly about the science that we care about, we should see to it that our colleagues, the administrators who have to make decisions about facilities and about safety in the laboratories -- we have to see to it that they share our conviction about the importance of laboratory work. I think the great master, Leonardo, said it much more eloquent that I can say it. He said, "There is no higher or lower knowledge, but one only, flowing out of experimentation." It

is the pursuit of experimentation and it is the interplay between theory and experiment, that we must understand and we must be able to communicate to others.

I am happy to tell you that the National Science Board, exactly a month ago, accepted a report from a special task committee that dealt with the question of undergraduate science, mathematics, and engineering education. I urge you to read this report and to act on its far reaching recommendations that are addressed to various sectors in our country including NSF. The recommendations made to the National Science Foundation call for leadership role and for leveraged program support of about $100 million dollars over the next two budget cycles -- fiscal year 1988 and fiscal year 1989.

I think I did mention to a couple of people earlier tonight when I was asked about the button that I'm wearing -- "science is fun," I said that, at the banquet, I will distribute the few buttons I brought with me. I have about a hundred. Also, I brought for my physics colleagues, a small gadget. And I have maybe 500 of those. It's actually a small disc. And if you listen carefully, you can hear this click. This is a bimetallic disc. And there is a message on the inside of the disc. I'll let you read the message, and then I'll also give you some instructions on a small piece of paper, in case you don't know how this works. But I do want to close by making a special presentation to Professor Weisskopf and to Professor Leon Lederman, in that order. I'd like to present you

this (a green chemiluminescent light stick is presented) -- for showing us the light.

(Applause)

And Professor Lederman, I'd like to present you with this. The color is indicative of a message (a red chemiluminescent light stick is presented).

DR. LEDERMAN: What message?

DR. SHAKHASHIRI: That the National Science Foundation budget is in the red --

(Applause)

DR. LEDERMAN: I hope this is not "stop" and "go." It's certainly not politics. I -- I don't know what to say -- that doesn't work.

(Simultaneous Discussion)

DR. LEDERMAN: I would just say that I think one of the important things that we have to look forward to with Washington is the question, which I'm sure Dr. Shakhashiri often faces, and the question is often asked, "Why should the Federal Government be involved in education today? What have they got to do with it? This is a responsibility of the states. And at one point, his ...