NATIONAL SCIENCE FOUNDATION
NATIONAL SCIENCE BOARD HEARING

21ST CENTURY EDUCATION IN SCIENCE, MATHEMATICS AND TECHNOLOGY	)

MARCH 9, 2006
UNIVERSITY OF SOUTHERN CALIFORNIA
LOS ANGELES, CALIFORNIA

APPEARANCES:

BOARD MEMBERS:

STEVEN SEMPLE, PRESIDENT
JOHN STRAUSS
JOANNE VASQUEZ
STEVEN BEERING
MICHAEL CROSBY
ELIZABETH HOFFMAN

DR. CROSBY: Can I ask everyone to take their seats. Good morning. On behalf of the National Science Board, I would like to welcome you all for joining us today on this important third and final board hearing on 21st Century Education in Science, Mathematics and Technology.

I'm Michael Crosby, the executive officer of the National Science Board and the director of the board office. The Chairman of the Board Dr. Warren Washington asked me to express his regrets that he could not be here with us today.

For those of you who are not familiar with the National Science Board, the Board has two basic responsibilities under the 1950 NSF Act. The first is to serve as the policy setting and oversight body for the National Science Foundation, and the second is to serve as an independent body of advisors to the president and Congress on national policy issues related to science and engineering research and education.

Now, I'd like to introduce board members that are here today for this hearing, Dr. Steven Beering on my right, who has been appointed by Dr. Washington to lead this activity on behalf of the National Science Board, Dr. Beering is President Emeritus of Purdue University and the Chairman of the Board Subcommittee on Science and Engineering Indicators.

We're also very fortunate to have with us several other board members, Dr. Elizabeth Hoffman, chair of the National Science Board Committee on Education and Human Resources and President Emeritus of the University of Colorado.

Dr. JoAnne Vasquez, the past president of the National Science Teachers Association, and I might add the only member whose career was actually in precollege teaching and a primary author of the Board's just released policy paper on K-12 science and math education.

And Dr. John Strauss, president of Harvey Mudd College and chair of the Board's task force on international science partnerships. And now I'll turn it over to Dr. Beering.

DR. BEERING: Thank you very much, Dr. Crosby, for this kind introduction. We are very pleased at the great interest that has been generated by our activities in regard to the proposed board commission on precollege education in science, mathematics and technology. We're gratified by your attendance here today.

We especially appreciate the support and encouragement of our host the University of Southern California for this event and for your wonderful president Dr. Steve Sample, who's been a lifetime friend and colleague of mine.

Now, a few words about why the Board is considering a new commission on education. The commission on education falls primarily under our statutory responsibility in national science policy advice, although science policy recommendations by the Board will provide guidance also to the National Science Foundation itself.

If the board establishes a new commission, it will be the second commission on education. The first was established in 1982. The stated purpose to define a national agenda for improving mathematics and science education in this country. It was specifically charged to develop an action plan to include a definition of appropriate rules for federal, state, and local governments, professional scientific societies in the private sector in addressing this national problem.

At the National Science Board meeting in March of last year, our chairman, Dr. Washington, informed NSB members of a number of requests from a range of organizations to reconstitute the '82, '83 NSB commission on precollege education in mathematics, science and technology. Perhaps most notable was a congressional request we received during Dr. Washington's testimony earlier in 2005 at the House Appropriations Subcommittee hearing on the NSF fiscal year '06 budget.

The charge for such a commission has yet to be determined by the Board. But we have received a number of somewhat different suggestions on the direction this activity might take. Therefore, in September of '05, the Board agreed to implement a

process for considering a charge for a new commission. I would also like to mention that the '82, '83 commission study was coordinated with another commission under the Department of Education.

The Department of Education commission produced the report entitled "A Nation at Risk" that effectively drew attention to the weaknesses in the U.S. system generally. Because the efforts of that commission and other studies convincingly established the problem, the '82 board commission aimed toward an action agenda involving all sectors of society to address the very serious problems facing America's elementary and secondary education systems in math, science and technology.

Its agenda was directed toward the nations achieving world STEM education leadership by 1995 as measured by student achievement and participation level and other subjective criteria. Silently the excellent work of this previous board commission and the many subsequent organizations concerned with the quality of science, math, and engineering education have not produced the desired results in U.S. student achievement that are needed to sustain U.S. preeminence in science and technology for the future.

In fact the Board has recently released the next volume of its bi-annual statistic report, "Science and Engineering Indicators 2006" in a companion policy statement to indicators entitled, ""America's Pressing Challenge: Building a Stronger Foundation." The Board companion piece underscores the need for a more effective K-12 system for STEM education.

The data reported in the new indicators volume suggests that American education in science technology, engineering, and math is still not preparing our children commensurately for the future needs of a nation so dependent on excellence in science and technology.

We have provided you with a copy of the companion piece in the background materials, and they're also a copies of indicator CDs and packets of data cards highlighting some of the recent trends in STEM education and other areas. These materials

are available at the table as you came into the room.

In the Board's vision 20/20 paper for the National Science Foundation, recently submitted to Congress also, we identified the importance of solid grounding in the fundamental concepts in science and technology for all Americans. We emphasize a critical rule of a high quality STEM education in grades K-12 to ensure every student graduates from high school and able to participate fully in our increasingly technological world. We also have documents of that document available for you.

And we are pleased that others are drawing attention at the highest levels to our crisis in STEM education. Most recently the National Academy's, in their report, "Rising Above the Gathering Storm," and the president in his recent State of the Union address. We are hopeful that this high level of attention and concern for many sectors can mobilize our society to take the necessary actions now to deal with this intractable national problem.

Before we begin with the testimony of our various panel members, I want to again say how delighted we are to have with us today my friend and colleague, the president of the University of Southern California, the national and international leader in higher education, Dr. Steven Sample. You have all received a copy of his bio sketch, so let me without further adieu invite President Sample to make some introductory remarks at this time.

President Sample?

PRESIDENT SAMPLE: Thank you very much, Dr. Beering. Let me say at the outset that as soon as I finish my remarks, I'm going to leave for another meeting. And I don't mean to offend anyone by that. And I'm especially sensitive. I just hate to make a talk and then leave. And the reason is I had a traumatic experience in my professional youth.

The first scientific paper I was ever to give was to be given at the National Electronics Conference in Chicago. So my wife and I went out there, and

we found that my paper was to be offered as the last paper in the last session on the last day. And we got to the room. There were six papers, and there were six people in the room. And then when Catherine and I came in we augmented that a bit. As each speaker finished, he said, "I hope you'll excuse me, but I've got a plane to catch at O'Hare. And you know what happened. Of course, when I got up to give my talk, my total audience comprised of my wife and a very drunk projectionist in the back of the room. So excuse me if I absent myself.

We at USC are very pleased to have you meeting on our campus today. As president of the university and as a member of the National Academy of Engineering, I feel very privileged that the National Science Board has chosen to hold the final installment of these important hearings on our campus.

The members of the National Science Board represent some of America's finest minds in the area of science, engineering, mathematics, and education. And, moreover, you're helping to ensure the health and vitality of our national research efforts. Over the last two centuries, advances in science engineering and technology have been the primary forces of change in our society and in our world. Some of these innovations have emerged from work done at USC and by USC's own students, faculty, post-doctoral fellows and alumni.

Our scientists and engineers are solving societal problems, working to make this country stronger, healthier, and more secure and more prosperous. Let me just give you a couple examples of the outstanding research being conducted here at USC. We're blazing a trail with our Information Sciences Institute. We're now one of the birth places of the Internet in Information Sciences Institute or ISI, as we call it. It's a world leader in robotics, artificial intelligence, and computer security.

The Institute has received federal funding for a number of projects, including $58 million from NASA in the fall of 2004. We're doing innovative research and interdisciplinary research as well at

USC's integrated Media Systems Center. This is a national engineering research center funded by the National Science Foundation where we're working on the next generation of Internet technology.

We're also shaping the future at our Institute for Creative Technologies. This institute was established by a $45 million grant from the Department of the Army and was augmented by a $100 million research contract, which is the largest single research grant we've ever received. The Institute for Creative Technologies brings together experts from academe, the military, and the entertainment industry to explore how virtual reality technology can be used to train the next generation of soldiers and military leaders.

We're also helping to keep the country safe and secure with the Center for Risk and Economic Analysis of Terrorist Events, which works out to a very nice acronym, CREATE. As the nation's first homeland security center of excellence, CREATE uses multi-disciplinary research to analyze the risks of terrorist attacks.

USC is working to ensure that America remains prosperous and competitive by educating the best students from around the world. We believe in educating not only outstanding scientists and engineers, but also well-rounded young people with a firm grounding in the arts and humanities. We call this concept breadth with depth. We encourage students to pursue two majors or a major and a minor that are widely separated across the academic landscape.

One recent graduate of USC, for instance, had a double major in biomedical engineering and creative writing. Another student pursued a double major in biomedical engineers and political science with a minor in economics. We're helping these students recognize that the intersections of disparate bodies of knowledge are where the sparks of invention are generated and where they can burst into the full flame.

We're also helping to develop the next generation of scientists, engineers, and inventors through our outreach to the community. One of the ways we're doing this is through the USC Science

Technology and Research Program, or as we call it the STAR program. The STAR program is a collaborative venture between USC and the Francisco Bravo Medical Magnet High School. The STAR program brings inner city juniors and seniors in high school to join a basic science research team on our health sciences campus. They do real hands-on work in real laboratories with real faculty, graduate students, and post-ops. More than 50 laboratories at our health sciences campus participate in the STAR program. This program is one way that USC is helping to enhance education in science and technology well before these students start college.

Later today, you'll hear more about USC's commitment to educating the next generation of scientists and engineers. From our Provost and Senior Vice President for Academic Affairs Max Nikias. I hope that your discussions today will be informative and engaging, and I want you to know how pleased we are that you have chosen to be here. Thank you.

DR. BEERING: Thank you very much. Before you dash off, are there any specific questions that our panel of board members have for President Sample?

PRESIDENT SAMPLE: Got off easy.

DR. BEERING: We'll mention that.

PRESIDENT SAMPLE: Thank you.

DR. BEERING: Have a pleasant day. Thank you for having us again.

Before we begin with our first panel, I want to again say how much we look forward to hearing from each of you, and we cherish your excellent advice and ideas. It is widely and increasingly recognized that achieving excellence in STEM education is crucial to our future national prosperity and security, and there are three questions that we ask each of our panelists to consider as they provide and prepare their testimony.

First, why have we not improved in the last two

decades? Second, can another commission as contemplated really add any value? And third, what incentives, programs, projects, new initiatives can we propose for students, families, and communities to get involved with this effort? However, excellence in STEM precollege education in this country is dependent on the aggregated commitments and efforts at the local level by school districts, teachers, parents, and children.

At the national and global levels, we understand that other nations are making their commitments and investing the energy and resources to raise their workforce capabilities in science and technology. And we know from trends evidence and science and engineering indicators that they are succeeding. We have been backed with excellent teachers, and they're now beating us at our own game.

While we too must think globally with respect to the education we are providing our future workforce and (inaudible), we must also act locally to implement changes to address the continuing and disturbing trends we have seen over the last few decades. We must not fail. We must succeed.

During the round table discussion which follows each panel, I ask that we contemplate the most effective rule for the federal government and the National Science Foundation as part of the federal effort to encourage world-class excellence in science and math in college education achievement by U.S. students in all communities. We are especially interested in how a newborn commission could contribute toward implementation of effective solutions to the problems that we have now experienced and enumerated.

We are also beginning to cooperate with the Department of Education once again and work together with them toward our common objectives. Before we begin hearing comments from our invited guests, I'm going to ask our National Science Board executive officer, Dr. Michael Crosby, to explain the procedures of this hearing.

Michael.

DR. CROSBY: Thank you, Dr. Beering. First, I need to make the usual announcement that we would like all cell phones and any other electronic noise-making devices that people have, if you would turn them all off, please, during the hearing.

As your agenda shows, we have several panel sessions. Board members will hold their questions until the appropriate point in the discussion indicated in your agendas as round table discussion. We request the speakers keep their formal remarks to no more than five minutes to allow time for discussion. And please speak up into your microphones. We are web-casting this as well, and you should be aware of that.

We will help you keep time with your talk, and we'll signal how much time is left. One of our able-bodied board science assistants, Ms. Clara Englert on the side here will stand up when your time is getting close to expire, and she will begin to walk forward towards you after your time expires until the time that she actually will be standing in front of you if you continue to talk. But she'll be very nice about it. Clara is good, yes. But we do thank you for keeping on schedule so we can have enough time for discussion.

And we've set aside time at the end of this hearing for those members of the public, folks who wish to provide some comments, so that we will have a public comment period if you have registered to speak. So you need to register upstairs at the registration table. And again, it is being -- this hearing is being broadcast live via the Internet, and we have a court reporter reporting the entire hearing. And we'll be very pleased to accept any additional written comments for the Board to consider from any of the speakers or members of the public. Thank you very much.

Dr. Beering.

DR. BEERING: Thank you, Dr. Crosby. So let me invite the first two panelists, Dr. Nikias and Dr. Gallagher to move to the table. And I want to make a special comment that I recognize Dr. Gallagher as a new graduate.

DR. GALLAGHER: Yes, I am.

DR. BEERING: When was that?

DR. GALLAGHER: I got my doctorate in 1982.

DR. BEERING: '80?

DR. GALLAGHER: '82.

DR. BEERING: I missed you by one commencement.

DR. GALLAGHER: Yes, you did.

DR. BEERING: Well, let us begin with Dr. Gallagher, and then we'll proceed with Dr. Nikias.

DR. GALLAGHER: Thank you. Well, good morning. I am Karen Gallagher. I am the dean of the USC Rossier School of Education. And like President Sample and Provost Nikias, I want to add my appreciation to the work of the Board and for your being on our campus today.

We must all work to revitalize our STEM education systems starting with primary school and continuing through graduate school. I'd like to focus on two particular areas of concern. These involve the questions of why, to a large extent, previous calls for coherent national initiatives emphasizing math and science education seem to have achieved disappointing results. And second, how do we recruit and retain high quality math and science teachers.

In terms of the first issue, I think the concern should not be framed as a lack of effort or willingness to improve math and science education, but rather as a reflection of the nature of decentralized systems in schooling that characterize public, elementary, and second education in this country. Let me explain. If we examine a typical fifth grade classroom, and the teacher in charge of this classroom, no matter what state, we would find several systems influencing the activities going on.

For example, multiple governmental agencies effect instructional, curricular, and assessment

practices. For instance, federal testing requirements for No Child Left Behind specifies literacy and math tests, but not science knowledge in grades K-8. State K-12 curriculum standards govern what students should know about math and science, but the standards are not uniform across the states. And the 15,000 local school boards in the U.S. adopt district math and science curriculum guides and specific math and science textbook series as part of local control over learning, not as part of a national agenda.

Furthermore, we find when a federal program sends dollars to schools targeted for specific uses, the dollars flow through state agencies like state departments of education or through county agencies where they're used in subject modification to meet specific state regulations as well as federal programmatic goals.

What all this points out is that in order to achieve a common national goal of increasing math and science literacy or producing more math and science professionals, the structural barriers of our K-12 public education systems cannot be ignored. Let me use California as an example and discuss science education specifically.

Until this year, California state-wide testing programs did not include science. There is an educational truism. What gets tested gets taught. So a decade after the National Science Council science education standards were adopted, our state is phasing in the testing of science knowledge in grades five through eight. By the way, California did not adopt the NRC science standards, but instead created its own. Instead, California adopted standards that focused more on science terms and facts than on conceptual understanding and problem-solving.

So neither the California state testing system nor the national No Child Left Behind testing system assesses science for understanding or problem-solving at this time. However, look closely at any given school or school district in California, and you will find schools and teachers and administrators and elected school leaders agreeing with you without hesitation that the need to produce more high school and college graduates

that choose science and math-related careers is important.

So I would suggest that the issue is not one of initiatives having gone unanswered or a lack of commitment. Rather, I submit it is an issue of a lack of capacity at the national, state, regional, and local levels to act in a united and consistent manner on this initiative. But this lack of coordination among levels and systems does not mean that little progress has been made since the NSB 1983 report.

Our highly decentralized system of K-12 education has produced highly qualified high school graduates who do indeed go on to college and careers in mathematics. We just have not produced enough of them. You will also find many examples of elementary and secondary schools working with colleges and universities like USC to deliver well-developed programs. These programs are based on state and national priorities and are offered to students and schools surrounding USC giving them the opportunities to learn and to go to college. And Dr. Sample stole my thunder, so I'm not going to mention the STAR program. They are in my written remarks.

So given such agreement in interest in programs, where is this disconnect? I suggest that all the recommendations that had been made cannot alter the structure of public education or the convoluted pathways in transmitting federal policies into actual practices in local classrooms. But my comments are not meant as an excuse to throw up our hands in despair. Rather we must develop metrics and performance indicators that acknowledge the decentralized system that holds all levels of the system accountable for demonstrating impact on student achievement.

In a recent California report called, "Similar Students, Different Results" we have research-based evidence that shows that in schools where all students achieve, teachers and principals demonstrate consistent behavior that, one, places a high priority on student achievement; two, implements a coherent standards-based curriculum and instructional program; and, three, uses assessment data to

improve student achievement and instruction.

If the NSB decides to establish a commission, why not systematically review current school and college-based programs that demonstrate evidence of student achievement and provide the resources to develop more of these programs in the STEM fields. We also know that retaining highly qualified new teachers is related to two conditions. First, support for beginning teachers during their first two years of practice; and, second, increased compensation.

Actually, by itself, professional support in the form of mentoring and feedback is a strong factor in successfully retaining teachers, more than just increasing salary. But taken together, these two policies are powerful in keeping qualified teachers in classrooms. Let's translate this knowledge into supporting more teacher development assistance in states and district, especially in the STEM fields.

The challenges facing science, math, and technology education are real. But the NSB could do more -- could bring more coherence to the K-12 educational system by recognizing its decentralized nature and supporting multiple approaches that are standards based and that insist on demonstrated achievement outcomes. By replicating successful programs and effective practices, we will produce more highly qualified math and science teachers, more students who are mathematically and scientifically literate, and more students who will choose careers in engineering or chemistry or, I hope, in teaching. Thank you.

DR. BEERING: Thank you very much indeed.

Dr. Nikias.

DR. NIKIAS: Thank you, Mr. Chairman. All of us at the University of Southern California would again like to thank the National Science Board for bringing this hearing to our campus. USC takes very seriously the issue surrounding STEM education. Thus, we are honored to play host to a discussion as significant as this one.

I would like to express my optimism regarding the American spirit and the competitive advantages that we can use to benefit our children. We at USC are currently celebrating our 125 year-heritage not only by honoring our past, but by pledging to event the future. Such a lofty ambition is one of the noblest desires of humanity, and the most prosperous societies achieve this ambition.

To make American soil as fertile as possible for invention and innovation, we need a unique educational experience. We do not need every student to be a STEM specialist in order for America to prosper. After all, America's dominance in commerce and culture is due to our rich land of communicators and scientists, musicians and mathematicians, artists, and professionals.

However, we do need every one of America's nonscientists to be comfortable on the technological frontiers of the future. And we do need every one of our future scientists to be driven by timeless values as they pursue a timely innovation. As you consider a STEM commission for K-16 education, I would like to offer some recommendations.

First, we can incentivize more students go deeper into STEM. Scholarships -- and this is really a fact -- are a simple means to do this, as was the case in the Sputnik era. Even nonscientists should recognize how STEM literacy can give them a career advantage. Next, we must revalue the American research university as one of America's greatest resources. Other nations cannot hope to duplicate this resource. America's 60 top research universities alone perform most of the country's university-based research, and they award the great majority of the country's doctoral degrees.

The money of educational experience that we need can be developed more easily at these universities than anywhere else. We can incentivize our research universities to leverage their broad capabilities so that they provide a firm foundation of technological literacy to nonscientists and a firm foundation of timeless

human values to our scientists.

Our overbranching goal should be to provide the most dynamic environment for innovation. A collaboration of academia and government is essential, and we also need to find ways to attract industry as an active partner. When all three sectors work together, it provides an incredible education of benefits for STEM students. Such collaborations helped USC win not just one but two Engineering Research Centers from the National Science Foundation, one in the area of multimedia and the other in the area of biominetics (phonetic).

There is an extraordinary advantage in inviting industry into the educational process. It allows our STEM students as scholars to get a solid understanding of the entire innovation process. This approach breeds rapid commercialization and dissemination of new discoveries. And fast commercialization of new technologies will help America remain at the forefront in a global economy.

We should explore sabbaticals and other incentives to draw STEM people from industry and government into part-time STEM teaching. We must seek the right compensation incentives to draw top STEM people into full-time teaching, and we must reassess our entire K-12 STEM curriculum. Finally, we must value cross-disciplinarity [sic].

As President Sample has noted this morning, it is not enough to merely have a broad education. We should want breadth with depth, a deep knowledge of two or more dissimilar disciplines. Take a student whose mind is strong in two divergent disciplines such as literature and medicine. That is the kind of scholar that can find new approaches and new solutions. That is a potential Renaissance man or woman for our new century. That is the student we are hoping to produce.

As one who came to America to complete my own engineering education, I found this nation to be a remarkable world-changing fountain of innovation. What the advents of Pedicles (phonetic) represented during the golden age, this nation represents in similar values and traditions today.

It did not wait and respond to the future. It invented a better future. That remains our opportunity even today. We at USC hope a university such as ours can be your partner in seizing this opportunity for the benefit of all those Americans who will come after us. Thank you.

DR. BEERING: Thank you very much. Let me add that our Board has had the benefit of your written testimony before today, and I found your utterances compelling and intellectually challenging and stimulating, and it's so wonderful to hear you talk now with such passion and purpose. Let me invite the Board to direct questions or reactions.

DR. HOFFMAN: I'm very interested in both of your comments about, one, about the importance of pay, better pay for teachers. And I wanted to ask you how do you believe, other than scholarships, you implement that in the current environment in which there is a considerable degree of difference in the quality of science and mathematics teaching across this country and the fact that we have many, many, many schools where science and math is being taught by teachers who did not major in math and science. Any one of you. And then I have another follow-up question.

DR. GALLAGHER: Well, I think the -- well, as I think I alluded to in my remarks, I think we have to inventory and find the programs that were indeed -- universities are turning out highly qualified math and science teachers and then following up on where they're getting hired, and reinforce the practices that we know from research work.

So we know that professional development in the form of following -- or helping first and second year teachers navigate not only their subject area and their teaching, but also how to navigate being a teacher in a system. We know that the investment of that is very important. So we should look to where highly qualified teachers are being hired and support and make sure we retain them.

In terms of the pay, since that is a local issue

negotiated usually between unions and districts, I think we can look at the opportunities in the summer to take teachers and provide professional development -- paid professional development, but not one shot, not one summer, but over two or three summers, we bring teachers in to work as teams on curriculum and effective instructional practices, send them back out into their schools the following year. Again, follow-up, bringing them back again so that we really -- it's that depth with breath -- breadth with depth. That they need to be able to try new things, see how it works, and then come back again and talk about it and do -- go back and do a better job.

DR. HOFFMAN: But that deals with the teachers who are here today. It doesn't deal with the fact that a young person who is very gifted in math and science looking at the future and seeing that -- if you get a Ph.D. in math and science and teaching university, your starting salary is going to be $75- to $100,000 depending on how good you are. If you go into industry, the opportunities are considerably higher. And you go into teaching, and you might make $40,000 a year.

To me that -- the fundamental problem is that we are not getting the best and the brightest people in math and science to even consider getting teaching certificates and going into teaching once they have gotten their Bachelor's degree in math and science. To me that is the key problem. How do we address it?

DR. NIKIAS: Let me share my views on that particular issue. If we look at the universities today, I think we have a very successful working model that our tenure faculty are a nine-month appointment.

DR. HOFFMAN: I understand. Non-tenured faculty are a different issue, I agree.

DR. NIKIAS: But there are so many funding opportunities for our faculty, and that's how they earn a higher pay by winning grants and doing research and getting around either a 11- or 12-month salary so they can achieve that level. I think that one way to approach the challenge that

we face in K-12 with math and science teachers is to establish -- who by the way are also on a nine-month appointment at the very schools. That we have to provide a similar grant program.

And, yes, I know there will be some challenges, how K-12 schools can manage grants and contracts in this case, but there are, I think, easy ways to address that. You get grants from contracts offices at the local universities to help them with that. And if we offer these funding opportunities to K-12 math and science teachers, then the incentives will be there for them. And they can work during the summer. They can have collaborations, many teachers from various schools. There can be partnerships between K-12 schools and university STEM teachers, professors.

And, yes, I can understand the salary of a Ph.D. graduate, but for someone to pursue a career as a math or science teacher in a K-12 school, probably an undergraduate degree and then a Master's degree. I think that would be sufficient. And clearly a starting salary for a Master's degree science or engineer is lower than 75, depending on the discipline. But if the opportunity is there for the teacher to run three more months by being more active or seizing these opportunities to win grants, I think that the issue of pay can be addressed like that. And it's not going to be for everybody. It's going to be for those that are really driven to make a difference.

DR. HOFFMAN: Let me ask this follow-up question. What is your position on the increasing, for instance, IBM initiative to encourage retiring scientists and engineers to back and retool as teachers and utilize their extraordinary knowledge in math and science in the classroom? And how to do that in a way that does not frustrate them so terribly in the process of making the transition that we lose them.

DR. NIKIAS: I would -- I think it's an excellent program. There are -- I have met a lot of very talented engineers and scientists here in Southern California who work for the aerospace industry; that they have a passion to do that, and they feel they can truly make a difference for the local schools.

However, I would strongly recommend that there is some kind of a training program to prepare them. We don't just take them as soon as they retire and put them into the classroom. They have to go through a thorough and intensive training program. And then at the end of the day, since I have a high school -- my daughter is in high school, so I can speak from a little experience. There is nothing like a teacher who can inspire the students. Inspiration here is the key. It isn't how deep the knowledge that the teacher has on the subject. How inspiring he or she can be. And I have seen a big difference, even with my daughter, that they had a new biology teacher in the classroom, and it's truly inspiring, and that has made a difference for the whole class, and the kids love biology.

DR. HOFFMAN: And I assume he also knows his subject?

DR. NIKIAS: Yes, of course.

DR. GALLAGHER: Let me add to that, because I'm pleased to hear my provost say that besides the subject matter, it is also understanding how to teach, how to translate. And I think part of the inspiration of great teachers is that they not only know their subject matter, but they know the students in front of them, and they're able to connect the subject with where the student is. And that to me -- we have alternate paths. If they're from IBM, they're from universities. We actually -- in our Master of Arts program, we have a biology professor who's retiring and is coming and getting his Master of Arts in teaching because he wants to go and teach in urban middle schools. And so, I mean, this is the alternative route where you have your subject matter and your Pentecostal training, your teacher training. I think they're fabulous opportunities wherever people come from.

DR. HOFFMAN: Thank you very much.

DR. BEERING: Dr. Vasquez.

DR. VASQUEZ: Just one question, Dr. Gallagher. On the STAR program, what percentage of these

students have retracted to go on into STEM careers or become teachers?

DR. GALLAGHER: It hasn't been long enough that we have them getting out of college, but the figures I've seen is that over 75 percent of them are -- when they've gone on to college are -- have identified majors that are -- would be in the STEM. We have to follow it and see -- and I think you've hit a very important point. Let's look and see what really happens.

DR. VASQUEZ: How long has the program been in existence?

DR. GALLAGHER: I think about seven years.

DR. NIKIAS: Seven, eight years.

DR. VASQUEZ: Last one just to follow up. What about the teachers, the high school teachers that these students have? Is there some sort of mentoring program for them as well?

DR. GALLAGHER: Yes.

DR. NIKIAS: Yes.

DR. VASQUEZ: Because obviously they come back with all this knowledge.

DR. GALLAGHER: And as Provost Nikias pointed out, we bring them on the campus during the year as well as in the summer so that they too benefit from the same --

DR. VASQUEZ: They benefit as well?

DR. GALLAGHER: -- same kind of experiences that the students do.

DR. VASQUEZ: Is it possible that we could get some information about the STAR program?

DR. NIKIAS: Absolutely. I should point out also that -- and that was one of President Sample's early initiatives when he came here as president, outreaching, being very aggressive to raise a neighborhood here at USC that initially were the five closest K-12 schools to the USC campus. Now

I believe it's close to 12. The closest 12 K-12 schools to the USC campus, not only has the university embraced those schools, we provide their computing infrastructure and we maintain their Internet infrastructure. We train their teachers. We have all sorts of different programs with the kids throughout the year, including the summer. And part of it is the STAR program.

DR. VASQUEZ: Thanks. Thank you.

DR. BEERING: Dr. Strauss, any comments?

DR. STRAUSS: Well, as president of the Liberal Arts College of Engineering, Science, and Mathematics, it won't surprise you that I'll take some exception to your notion that the solution to the STEM problem lies solely in the 60 top research universities. But I will certainly agree with your notion that the breadth of the education, preparing people for productive citizenship as well as professional excellence is certainly important, and I will certainly second your notion of the importance involving industry partners. So I found your remarks very stimulating.

DR. NIKIAS: Thank you. Let me just clarify my comment on the importance of the search universities. It was more for the -- if it's an environment of science and technology innovation in terms of research. And then the (inaudible) commercialization of all those innovations.

DR. STRAUSS: I wasn't too insulted.

DR. BEERING: Everything has to be in context. Thank you so very much both of you for your enlightening comments.

Next we would invite the group of Terry Joyner, Todd Ullah, Larry Prichard, and Jerry Valadez.

Thank you for joining us. Let me suggest we go from left to right as I look at you.

Dr. Valadez.

DR. VALADEZ: Thank you. Please bear with me a bit. Good morning and thank you for inviting me

to address the panel on these critical issues we're facing today. My name again is Jerry Valadez. I'm the K-12 science coordinator for the Fresno Unified School District. I'm also the President-elect for National Science Education Leadership Association.

I work with and support science teachers in the large urban K-12 district that has been engaged since 1990 in a system-wide effort to improve mathematics and science. And with the support of NSF and the Smithsonian, we've come a long ways to improving the status.

I want to respond to the question about why hasn't the improvements stayed. There have been a number of oppressions including changing policies that I referred to in my written statement. But the most critical one today is the pressures we're facing on the accountability surrounding mathematics and (inaudible).

In responding to the pressures, districts are adjusting to meet those accountability pressures to lessen the classroom pressures for teachers, and in part has resulted in frequent administrative turnover due to a lack of vision. As resultant, an implementation in conflicting policies has resulted in curricular anarchy. And I'll explain what I mean by that in a few minutes. As well as curricular oppression. And also has resulted in ancient (phonetic) cultures that exclude K-12 achievement gaps as an improvement strategy for themselves.

The oppression I observe is the elimination of the teaching of science, and inquiry, from our elementary and middle schools. Carl Sagan warned us of this hazard just before his death in 1996 in his book, "Science as a Candle in the Dark: The Demon-Haunted World." He warned of what would happen to our society if we did sustain a strong science and technology education. He stated, "As the candle flickers and the darkness gathers, the demons begin to stir." We all have our own demons, however, a misdirected focus on language arts and reading void of content has created darkness and the candle of science is flickering dimmer and dimmer.

The focus on language arts for the sake of reading in the content areas is itself becoming contentless. Reading is not a content area. Even so, science has now been marginalized to the point teachers are allowed to teach it only ten minutes a week or maybe once a year during science school or sometimes on rainy days. An array of assessments -- norm-referenced and standards-based -- has defined children's future, a future that has been determined by institutional segregation based on flawed comparisons of data from those assessments.

I have observed a predictable reaction to this new standard of American education. Entire districts have been restructured to focus only on those subjects that are tested for NCLB accountability. All resources have gone to "teacher to the test." It's a natural reaction supported by the market economy that drives all education. Entire industries have refocused their energies to support "teaching to the test."

As a result schools are more segregated than ever, segregated into those that have and those that have not as a result of the social engineering, although not intended, by NCLB. What I mean is those that have science and those that do not have science. And why is this important? Several studies clearly indicate that science course taking in high school is a strong predictor of post-secondary education choices. We know this, yet we continue to support a system that keeps our children from realizing opportunity as a result of curricular oppression.

Recommendations that I would put forward, and there are a number of them in my written testimony today. NSF's experience in successful record of peer review programs makes their role in this improvement process critical. I believe that we should go back and look at those successful models again and see how they can support and sustain us.

Leadership capacity in science and mathematics education for K-12 systems must be addressed. Most districts do not have the required leadership to effectively initiate the improvement process. This country must again set high expectations of science learning for all districts, schools, and

students. When appropriate learning environments are provided, all students can increase their knowledge, understanding, and appreciation of science and mathematics. Every superintendent, administrator, building principal must embrace the science education needs of their students.

As was said earlier, curriculum instruction and assessment must be aligned to improve science literacy, and science must be assessed every year and be included as a measurable goal with AYP. Pedagogical strategies to support English Learners success in mathematics and science are well-known. We maybe should look at special training and certification for science teachers and English Learners and support them any way we can.

I've also heard, you know, how can we sustain teachers in our system, current teachers in our system? And one of the things that causes teachers to leave our system is that they don't feel supported. And, again, that's partly due because of changing policies that drive budgets. I have many teachers in my district and others that are trying to support chemistry classes, for example, on a budget of $1 per student per year. And now we're driving to increase enrollments in AP classes without looking at the infrastructure and the support the teachers need to do that.

DR. BEERING: Thank you very much.

Dr. Todd Ullah.

DR. ULLAH: Good morning. I'm Todd Ullah, Director of Science for the Los Angeles Unified School District. And I'm happy to be here today representing our school district. I welcome the opportunity to be here today on behalf of our superintendent of Schools, Roy Romer, and our chief executive officer of secondary education, Mr. Robert Collins, and the over 750,000 kids engaged in science and mathematics education each day in our district.

This Commission's work is vital to the interest of children and families of urban and rural schools throughout the nation. It is our belief that STEM education is critical to the national security and economic prosperity of the nation here in the 21st

century. The children occupying our seats in the nation's largest schools and cities need access and quality of opportunity regarding an education in general, and science education and mathematics education particularly.

Public education must succeed in providing a rigorous, culturally relevant, comprehensive standards-based education for all students in our schools. I would also like to emphasize this point by indicating that we must close the achievement gap by providing sound instructional support and culturally relevant strategies to the nation's science and mathematics teachers in explicit ways to help them provide this rigorous and relevant education for learners we find in our schools today.

Our district is reaching out to make this happen every day in our schools through our theory of change or action in instructional guides, diagnostic periodic assessments, and intensive ongoing professional development for math and science teachers. In this quest, we focus on building leadership capacity in science and math vertically within schools and horizontally across schools.

We fully believe that developing leadership with a consistent direction within a constantly changing educational landscape is very, very important. This we believe will help the district go to scale in implementing incremental sustained changes in teacher practices. We believe that in order for the districts to improve public education and heed the recommendations and alarms of previous reports by this commission and other men in economies worldwide, a series of key supports and risks must take place in the nation's schools.

One, focus on instruction. We believe that's absolutely critical. Challenge students with high expectations and give them support to reach their potentials. Two, make abstract concepts in science and instruction concrete showing teachers, administrators, the public what it looks like in practice. Provide content and pedagogical development that focuses on inquiry-based standards-driven instruction that honors students' prior cultural knowledge and patterns of home

discourse based on language and other factors.

Continue to use system-wide as well as classroom-based diagnostic periodic assessments and aim intervention at grade credit recovery and eligible readiness. Point classroom extensions towards apprenticeship experienced in kinetic abstract concepts in science for real world for experiences that we all have.

Students are familiar with and they're engaging while strongly tied to schooling. This can only happen with inspiring teachers in teaching teacher. Take responsibility for public infrastructure, science facilities, professional development centers, and other intermittent programs that will sustain the kind of support necessary to assure that schools have access to curriculum and professional development.

Coordinate lessons and lesson plans in instruction units across schools and grades so they start articulation between them. Fund parent participation at all grade levels with intermittent programs. Attend -- and this is all, again, focusing on instruction. Attend to recruitment retention and morale of new teachers and experienced teachers. Now, that's a big focus in our district at this point in time.

By developing policies, procedures, and support, physical infrastructure that support rigorous inquiry-driven, standards-based instruction, that's very important, as we feel, the No. 1 reason science teachers leave in three, four, five years is inadequate science laboratories and tools associated with doing science. Treat teachers as trained professionals and educators that they are and seek input and collaboration in designing curriculum and pay them well.

Remove the legacy culture that regards teaching as a low-skilled work, a profession that has failed to develop a practice and controlled entry based on mastery of that practice. We need to really raise the level of the knowledge the public has with regard to teaching as a profession. Focus on building leadership structures that build capacity we have to collaboration. And really importantly to revitalizing the structures that help teachers

revitalize the energy of administrators. That's really important as we look at teachers burning out in our classrooms, especially in urban education centers.

Support partnership structures and the institutes of higher education, as we've heard earlier today, that focuses on changing the culture of both institutions so that STEM faculties see a value in expertise of leading mathematics and science teachers, the stars in our schools, in our district and nationwide. Then they will begin, we feel, to refer more of these students towards careers in education and also gain a better understanding of what public schools do need to know and be able to do.

Create greater awareness of teaching mathematics and science by honoring teachers publicly, something we must start doing here in Los Angeles annually with science teachers. Support the notion and recognize efforts that engage the community in continuous improvement by increasing R and D, research and development. There is a research and development component in both K-12 and higher education to sustaining development and support. Studies of effectiveness, various support models in development, content, pay, et cetera. Require a public investment. And we heard Elmore say this repeatedly in conversations he's had with the math and science community.

Three, elementary middle school and bridge programs in science and mathematics. As we look at the pipeline of our students, I think bridge programs between fifth graders and eighth graders are really, really essential in looking at their gaps and conceptual knowledge as it relates to mathematics and science.

Public investment and some after-school programs for these students would really go a long ways towards enrichment -- for both enrichment and invention as we look to improve education. Fund the parent component that allows access and engagement. And finally, follow up with high school internships and industry programs.

Lastly, four, build university business, city, community, and museum partnerships that support

one through three. I'd like to thank you all for hearing this testimony this morning. It's very, very critical that we engage in this conversation nationwide to help our students learn mathematics and science.

DR. BEERING: Thank you very much indeed.

Mr. Prichard.

DR. PRICHARD: Thank you. Let me say that my sole purpose for being here today is very simple. I had to fly out of Kentucky to come down to Los Angeles. That was a heck of a ride. Let me tell you that the reason I came was very simply because I wanted this board to hear the rural area problems that we have facing us every day not only in math and science, but in our education, particularly in math and science.

First of all, we are a rural area. We have access to large metropolitan areas like Lexington, Louisville, Huntington, and Charleston, and places in Cincinnati and places like that, but we're not even -- we're 90 miles to 110 miles away from each one of them. One of the things that I think as I look at these STEM initiatives that you're asking us to look at and try to advise you on is very simply that in the rural areas, we do not have the role model issues that the big cities have.

For instance, our engineering jobs and other jobs that are math and science related are not pursued by our students even in moderate percentage because they don't see them, nor drive by a big scientific building every day or have an opportunity to see that.

Students and people in our area tend to want to stay there. They're reluctant to leave home. They believe highly in the culture of you can make a living here, we did, our grandparents did, and their grandparents did, so therefore there's not a whole lot of reason for you to get involved too far into studying. A lot of issues face us, like, for instance, 20 to 25 percent of our students in our school system are raised by grandparents.

When you look at the issue of professionals in our area, there are not a lot of engineers, doctors,

scientists, or other math or science-related industries to serve as role models right there in the area for them to see. Few of our folks can afford virtual high school, and few of them have computers. We're probably looking at 30 to 35 percent of our students who have computers at home. That is absolutely (inaudible), a fact of life.

We do not have a research technology area in our area that we can do community research. Many of our libraries are not relegated to that area. Even in Carter County, they don't even have a public library. So you can see what we're up against in that area. We have no suitable place for large group instruction. On this each educator should speak. I wonder if they also have large group instruction, because as we look at the scientific way of creating a new initiative or teaching and learning in our schools, we're going to have to go toward some of the university models of large group instruction. And I believe we're going to have to do that. That's been one of the initiatives as superintendent that I've tried to convince our board that we need to do.

In many instances in education, reform or restructure or the initiatives just become another thing to do. They're put on shelves like everything else that's done. And that's so sad, but it's still so true. One of the problems that faces us daily is that I don't think that our people believe the reports and the statements of eminent bodies. I think they see too many other things. As I listen to these gentleman speak, the other issue is in the classroom. They listened to the lady speak this morning who talked about all the other things that are there in the classroom.

In our area, we not only talk about the No Child Left Behind issue, we talk about cast testing, we talk about standards, and we talk about this, and we have other initiatives. And then right in the classroom, we have health problems. We have all the issues that there are there that are looking at the teacher every day, that they face every day.

So how do we do this? I believe -- and I'm glad to share we have another problem, and it's not

urgent enough for us to do something about it, but we will eventually get there, I guess. But we do not prepare our students at the college level. And this is an indictment, in my opinion, on the universities and colleges, is that they do not prepare the students to teach the right way of how to get something across. They're teaching the material and they're teaching the pedagogical of how to do that.

But the task of getting the material across to students takes a lot of time to teach that, and I don't think they take the time to put those students through that rigorous investment they need to go through. Teaching them the importance of the importance of the inquiry method of real world connections just becomes a task for them that we need to do something about.

In our district, we're virtually out of math and science teachers. The universities that surround us are not producing them. And we are also doing the math programs, which we're using retired engineers, retired math people, retired chemists, retired -- anyone we can get to come take the math program and go into our schools and teach, we have to do that. We have a cadre. I established a cadre of future teachers of America in our school and worked with the local university to get full credit so that they will stay in the teaching field. How many of them will go into math and science is still a mystery, as we are not able to determine that at this point.

Our other issue is of high expectations. And the subject that we have is negative resistance. There are many reasons why they do that. The high expectations seems to be the one that frustrates me the most as a superintendent, because I believe that unless we have high expectations for our students, we won't even be there. We won't do that. But first of all, let me give you -- you know the analogy of give a man a fish, and he'll eat for a day. Teach him how to fish, he'll eat for a week. Our areas that we want to talk about and try to bring to your attention is we need a place for them to fish, not just teach them how, but they need to have a place.

I met with the vice president of Kentucky

Christian University just yesterday. And I said to him, I said, "John, first of all, I'm going to need a lot of prayer because this issue right here is not going to be one that's going to be easy for me to do," coming out here and talking to you guys, because when I think about the thing that he brought up and said so vividly and both very clear to us is there is a large gap between rural education and rural people, and city and urban education and city and urban people. And that gap is huge. And I did not realize how huge it is. But yet, we do have some very, very good resources that we could offer.

We have bright, intelligent, wonderful students who need to have some kind of a challenge, some way that we can get to them and reach them so that they also can see the importance our math and science initiatives that need to be done. In the past we have not been knowledgeable enough from our K-12 perspective to show vertical connects from grade to grade. And I believe that is an issue that one of the other folks talked about. This standard model needs upper education, K-16 initiatives to stay informed through the network of science and some type of a cadre.

National state standards need to align and support the goals that are set by an agency that makes it count. I mentioned it to someone just a minute ago. Those things that get monitored get done. And No Child Left Behind has not had a science component, but it will have a science component in the future. One principal should be the funding, I think, of a regional commission that will oversee other funding issues, standards, accountability, assessment, and would report from this oversight committee, and they could also pull funding or reward funding.

One of the science teachers, as I was talking with them about this issue, is justifying in front of you guys very simply this. He said, "How could we teach accuracy as part of our goal curriculum when we have scales to measure our material width as we do experiments that are very, very far inferior to the scales of industry?" Well, that's a good question. Why can't we have the very best equipment in our schools to do that? And that's a good question. I will ask you guys.

I have to say that I have read a lot of these testimonies, and Dr. Stage had an exceptionally good process. I hope when you listen to her that you'll see one of the two things out of there is the qualitative and quantitative issues that she brings forth. I really believe if we work on the qualitative issue of our work, that we can get the curriculum instruction up, we can do it, but it's going to take a lot of effort for that. And, again, it's going to take some funding.

I will also say that I'm sure that you guys that have been part of the National Science Foundation know what the Appalachia Math and Science Project is. The Appalachia Math and Science Project is an issue that came about to me because I believe that P-16 -- we have a P-16 council. Let me just talk about that. We have somewhere in the neighborhood of 40 percent of our students in Appalachia going to college without being prepared in science, math and language arts and English. And they have to take a lot of courses to get up to the credit courses to do that, and there's a big gap in that.

We wanted to try to stop that type of bleeding, because parents have to pay for the nonacademic courses, and we wanted to stop some of that also. What we did was we formed a P-16 council, and we worked with our three universities in our area, and we set the process to be the math process, And we worked with that. We aligned all of our math to the ACT. And we found that the work that we do in Kentucky and the tests that we took in Kentucky, there were 58 study pages to get up to the connect -- to the connect to work ACT. That has worked. That was a segue for us to go into the Appalachia Math and Science Project, which has been an exceptionally good project for us, because we are now moving forward in both those areas, so -- I saw her stand up so I'll stop.

DR. BEERING: Thank you very much indeed. Last but not least, Dr. Joyner.

DR. JOYNER: Good morning. Terry Joyner, Chief Academic Officer for Cincinnati Public Schools. And it is my pleasure to be here today to address some of the issues that impact urban districts and the quality of mathematics and science

instructions. In my present role, I am overseeing the implementation, curriculum and instruction in all the content areas. I've actually served as the curriculum director and curriculum supervisor for mathematics and science in PreK-12. I've had the opportunity to participate at two NSF projects. I am in Co-PI, PROM/SE, MSP, which is a partnership of five district Consortiums over two states, Michigan State University. And I've also participated in a local systemic initiative in the state of Delaware.

My comments today, as well as many of the comments that you've heard, are to really focus on the challenges that we have in ensuring quality teaching and instruction in mathematics and in science. I need to put my comments in context a little bit with the Cincinnati public. We have 35,000 students and around 1,000 teachers. 71 percent of our students are children of color. 16 percent are children with disabilities. 67 percent are on free, reduced lunch, which is our poverty index. Of the 1,000 teachers, 200 are long-term substitutes, 81 of those long-term substitute teachers are pursuing an alternate educator's license, and 23 of the 83 are pursuing that license in mathematics and in science.

Our curriculum efforts over the last five years have focused on the alignment of the written taught and testing curriculum of the state and national standards. We've selected research-based materials, we've imbedded the best in development, utilized content coaches, developed benchmarks for short-cycle assessments, and we've also incorporated a tracking system, electronic tracking system to monitor and track student progress. But unfortunately we are still challenged by funding cuts, limited parental involvement, and the requirements of No Child Left Behind.

Our greatest challenge, though, is building the content knowledge of our PreK-6 teachers in science. We have tried to shift our focus away from teaching to learning. We've tried to get our teachers to embrace the idea that the schools control the conditions for children to be successful in that if a teacher teaches, it doesn't end there. The student has to ultimately

learn. And that's a philosophical shift that most people take for granted is actually happening because teachers teach our profession. But it's not always about learning. So we really try to focus our discussions more on learning, tracking learning, understanding the misconceptions that children have, addressing those kinds of instructional strategies that meet the needs of all students.

This requires all teachers to have a real deep understanding of mathematics and science. So in asking what can be done, and how the National Science Board can actually help us, I believe that first, as many of my colleagues said, we really do need to call for national accountability for teaching science. No Child Left Behind requires an assessment of science, but it does not require schools and districts to meet adequate yearly progress in science. And because of that, schools and teachers are placing less emphasis on science instruction and less time -- and more and more time, as was said earlier, is going to language arts and other content areas. There's really no time left for science in some of the classrooms.

A second recommendation would be that we clearly articulate national standards grade level indicators and nationally aligned assessment, as also has been mentioned. I think the new -- a set of new standards have focused on fewer topics, and that built for articulation would be critical to benefit science in PreK-12. I think we also need to advocate for a pretty clear course-taking sequence for high school. Right now we have a hodgepodge of random choices that high school students can select to -- before they graduate. And many of our students are not coming to higher ed with the background knowledge that they need; although, they have the required number of credits.

I think the other -- another recommendation would be to ensure that every school has quality curriculum materials. There are many NSF funded and NSF developed or other developed materials that are good and that we know are making an impact. However, they are not in the hands of every school. And I think being able to provide those materials and the opportunity to integrate

those materials into other content areas would be a benefit. Teachers would not believe that they're recreating the reel every time they need to teach a science lesson.

The fourth recommendation would be mandatory inservice and preservice professional development. Our biggest challenge -- and one of our biggest challenges is that professional development is voluntary in most cases. And it's generally pretty much focused on the mechanics, the how-to. Teachers shy away from professional development that challenges their misconceptions and their understanding and the application of their understanding. And when we give them a choice, they tend not to take the kind of professional development that we know is going to impact the quality of their instruction. The support should actually be paired to what happens in the classroom during the school day. And that's going to require that there are math and science coaches, professional learning teams, and partnerships with external agencies, either higher end or corporations in order to make that happen.

And, finally, I believe that we really have to put some focus on building and sustaining high quality teachers. Teacher turnover and staff instability is a critical factor in urban school districts. We probably retrain about 50 percent of our teachers every year either because they come in from another district, or they've been moved and changed grade levels. And we are constantly retraining, and many times we invest many, many dollars in training, and then teachers leave our system and go somewhere else.

I think the greater likelihood that we have partnerships established that support individual schools as staffs go through transitions, the greater likelihood we will have in success in ensuring the teachers are maintaining their professional building skills. I also think that creating partnerships would also ensure equity in our systems. We many times have schools that develop partnerships with certain agencies or corporations or higher ed, and they may then benefit from a variety of different resources, either tutors or mentors or additional materials and supplies where other schools, maybe sometimes

right next door, may not have that same opportunity. And so we create inequity in our school system because we don't have a systems response to support across the district.

I think these are just a few recommendations that we have been struggling with in our systems because of the mobility and turnover of staff, and I appreciate the opportunity to share that with you.

DR. BEERING: Thank you very much indeed. We open it up for questions and reactions. Ms. Hoffman.

DR. HOFFMAN: Well, I'm going to ask all of you the same question plus two questions I asked of my colleagues from USC. One, I understand you have a very special problem, Mr. Prichard, that is quite different than perhaps the others. But how do we address in the long term the problem that we are not attracting the best and the brightest young people in math and science to become teachers, and that we have a woefully inadequate percentage of our schools where the teachers actually have the content knowledge, actually majored in the subjects that they need to be teaching. And my understanding is that it's far worse at the K-8 level even than it is at the 9 through 12 level, because at the K-8 level, the average teacher is probably math phobic and science phobic.

And then second, the question of the use of professionals. Obviously there's a need for passion. Obviously there's a need for additional instruction in how to be good teachers. But to me, those are the key questions. That's a challenge that we raise in our companion piece to our science and engineering indicators, and I'd like to hear how each of you would address that question or those two questions. Thank you.

DR. JOYNER: I don't believe -- I'm not going to say that -- the situation is not critical at the high school level. I do believe, though, that the high school teachers are coming in with the content knowledge, the skills and abilities that they need to teach the content.

DR. HOFFMAN: Some of them.

DR. JOYNER: Some of them. And if not, it's much easier to retrain high school people. I think our biggest challenge, as I said before, are K-8s. And those are not science or math people. They are elementary people. And they have to know it all. And so it's going to be very difficult to get those teachers who are focused specifically in math and science. We just won't get them. They will go to the middle school or they will go to the high school if they want to specify that they're going to teach math and science only. So it's about how do you build the content knowledge and the capacity of the K-8 teachers to be able to do it all and to do it all well.

And I believe that given the current teaching force, we can't retrain all of those teachers. In our case, that would be most of our teachers. Our new teachers coming in are coming in with pretty good standards-based knowledge. I think at this point, it is about co-teaching. It is about coaching. It is about making sure that there is someone in the classroom who is demonstrating, modelling for that teacher on an ongoing basis -- and this is not a one-shot group -- but an ongoing basis quality lessons and quality instruction.

DR. VALADEZ: We do have people out there that can take on the job. And most of them are at our community colleges. I'd say 80 percent of our teachers are in community colleges. And we don't have a good pathway from K-12 to community to our four-year institutions that will produce the teachers that are ready to walk into the classroom and take on the challenges. Most administrators, principals want teachers that have, No. 1, management skills. They don't look for content knowledge. They want teachers who can handle the kids, No. 1 so that they won't (inaudible). That's what's happening in middle schools. They're bringing up elementary folks who have good management skills, No. 1, and then if they can teach science, that's at plus.

We need to support teachers to teach science and mathematics the way our vision has been painted, and our systems aren't built to do that. We need to do some deep restructuring of our schools and finance it to be success. And then we can, you know, sort of plunge the dike, relieve the dike so

that we don't lose the teachers that we have, and then we can begin to build from there. But we do have the folks out there. It's going to take a concentrated effort to build a strategy to really strengthen the work that we need to do.

DR. ULLAH: Yeah, I concur with my colleagues in Cincinnati and Fresno with regard to content and pedagogical knowledge for K-8. That is definitely a need that we see in Los Angeles as well. But I want to take a different slant on the improvement of teachers and to our profession. I agree 100 percent with Dr. Valadez that community colleges and the pathway from a community college into a science or mathematics career is absolutely essential. And here in the L.A. Basin, we are working very diligently on creating partnerships that does just that. And we're doing that through constructing -- we're part of a national MSB grant called Scale that is constructing -- we're constructing emersion content that takes a teacher and -- pedagogically in content (inaudible).

The interesting thing about the grant is that university professors, STEM professors, college education professors, our teachers and staff are engaged in developing these units to gather around the framework here in California. And that's beginning to impact -- we're working with our teachers our universities -- are beginning to take a look at the importance of the work that's going on in K-12 education here in the L.A. Basin. And so we're starting to see results, and then referring some of their -- some of their kids that they're working in the STEM departments to the education field, which we want to really foster. So that's starting as a long-term approach, but I think that there's a lot of viability in supporting grants and programs with universities in K-12 that focus on that type of articulation.

I would also say that systemically reducing class size has a systemic issue in science education in particular. Here in Los Angeles we're dealing with 38 to 40 kids in a classroom. The job from a young person's perspective that's in a STEM department in seeing that is not really that attractive, so systemically we need to reduce class size while improving facilities. And that takes an investment and a focus nationally through

our monitoring programs and accountability programs to institute that type of grand level scale change. And so I would say that those two indicators and supports are really critical in moving our kids from the STEM areas of the community colleges into our schools.

The idea of using retired professionals, it's a great idea. An alternative is a certification program. It would be very helpful. Although, we're finding that the idea of pedagogical knowledge, retired folks going into classrooms from STEM areas, we need to give them a lot of support, encouragement, and really connect with their moral purpose on helping in this profession. So I think those are very viable ideas. And that's what we're kind of doing here in Los Angeles.

DR. PRICHARD: Let me say, first of all -- let's talk about at the present time. At this time we do job invented professional development.

DR. HOFFMAN: What's that?

DR. PRICHARD: Job invented professional development program. What we have is a situation where we've also had a lot of elementary people move up to the middle schools for whatever reasons. One of the only things I like about No Child Left Behind was they called our attention to what a highly qualified teacher should be and what they should look like. So from that standpoint, we had -- our plan that we now have in our middle school is science teachers teaching science and math teachers teaching math. Those people that came up through the elementary level are being moved out very, very quickly, and as quickly as we can. But if we can't move them out, then we have what we call job invented professional development. The Appalachia Math and Science Project is one of those things that gives us a lot of professional development in math and in science. So we do that.

As a future, looking at the future, our state is looking at differentiated patterns. I mean, we're just flat out landing on the line and saying, "We don't have math teachers. We don't have science teachers," and the other thing we don't have is

special education teachers, which is a problem. So what we're saying is, very simply, we're going to put some money on the line and say this is what it is, and it is what it is. In our K-8 program, our elementary school, the only thing I feel real bad about our elementary school issues is we don't -- we don't emphasize math and science the way we should. We emphasize math with language art, and we have -- we even have blocks of time set about, but we don't have anything that is science. And if we're going to ever look at the future and have our brightest and our best go into the teaching field of math and science, they're going to have to be introduced to it very, very young. It's got to be very, very early.

DR. BEERING: Will that take care of it? JoAnne.

DR. VASQUEZ: We know that in order for a student to construct any kind of knowledge, they have to be able do that kind of freely. We talked about this. And the issue with the funding -- and, Jerry, you pointed out the $1 per student for chemistry. How is it that we're going to convince the gatekeepers that we have to be able to have students do something besides wait until fourth or fifth grade, and we're just going to teach through the test so they can pass. I mean --

DR. VALADEZ: Again, a number of us have alluded to the sound research base of how students learn how adults govern. We tend to ignore that in education. And, again, it's been mentioned several times because of the market-driven economy. They're forcing us to do that. Again, it's going to take some deep restructuring and a hard look at what we really are putting out there in societal values. And it's going to -- it's painful. It's painful. We're seeing some shifts right now because of the tenure reform to build accountability around reading, for example.

And it's forced districts and schools to change an instructional day, to put all resources into the teaching of reading and the way they perceive reading should be taught. And it's now creating a generation of students that are void of science knowledge. And the knowledge they have is what they get from the projects that they're working on in the schools, which are pretty sound in

mythology and other stories. So, again, it's a difficult question to answer. Somebody is going to have to just make the decision and say, "This is what we want to do."

DR. ULLAH: Clear and present focus on science as being important nationally and how it connects to economic and security interest in this nation. And it needs that accountability factor for the early grades, needs to be there, and the supports in terms of the commission in helping the teachers.

DR. VASQUEZ: Okay. One follow-up about English language learners. And I know that concretely they also access academic language that way, and I think all children do that. And I guess how can we sound this alarm? I mean, what is it that you would say that we have a country of second language learners in science is one thing that absolutely turns them on, gets them to communicate, and gives them a purposeful learning. So what is it that we can do to present this issue? Any ideas?

DR. JOYNER: I think one of the strategies that could be a quick fix is that if science was a part of the annual yearly progress metric, then those subgroups, the performance of those subgroups in that English language learners and students with disabilities would be considered the same way we are now considering the math and reading achievement of the other -- of the other children in the subgroups. And I think that if that were the case, then science would not be optional anymore. It would be -- well, you know, this is going to hold us accountable statewide, and we would do -- raise these scores also. And I just think that if we could get the federal government to include science as an annual yearly progress metric, I think that would help.

DR. PRICHARD: I have to agree that anything that gets monitored gets done. The other thing is the high expectations issue. And yet when -- I'm assuming these folks just said that, that most of the time during the year, if we can find someone from the community who is influential to come in to read to students, we teach them reading. We say to them how important reading is.

Let me give you a real life example. I went to Kingsport, Tennessee to a math and science with the Appalachian Science Project. A guy -- doctor from Martin University Department of Science came and talked about nano technology. I didn't know what nano technology was. I had no idea. I still don't know what it is. But I looked into it to find out there was things about it. You know, we need a connection with the science world so our children can see that connection with the science world. That's why I emphasized to my board the importance of large group instruction, and I hope that didn't go over your head.

Large group instruction is very important if we're going to get interest in science and math done. A person coming in like the doctor who came in from Martin University and did work on nano technology to a group of people just like me, just educators, we're just educators, and we're, like, "what is he talking about? Why is this important to us? And why do we even need to hear this?" Yet, I look back, and the room was full, most everyone cancelled all other things to go hear this guy, watch his -- to see his Power Point and to understand what the research is doing.

Now, you think about those issues. If we could have that type of issue coming into our classroom on a daily basis, or on a weekly basis, someone coming in and sitting down and saying, "This is why science is important. This is why math is important. Look at what it can do." I was very impressed USC's work with the juniors and seniors. I'm going to try to do that kind of a cadre when I go back, see if I can't get that kind of interest started too. But that's really an interesting process that they're doing with juniors and seniors who want to be future scientists. I think that's one of the issue. And I see that as a bringing the reader in to show how important it is to read. Okay? How important is science?

DR. ULLAH: I think research really shows real English language learners strategies that honor student discourse, student talk, you know, in the classroom, cooperative learning strategies and writing critically in a science notebook, and in the early grades using the ideas of critical

literacy rather than functional literacy so that they write about their thoughts in science and have time to reflect on them I think has a great -- promises a great deal of hope for the students to have not just standard instructors but English language as well.

So those type of strategies and programs that support less teacher talk and more student talk, student work, with groups and each other honoring the discourses that come from home so that that discourse from home is carried to the classroom where the standard kind of educational academic language or discourse is matched I think shows great promise, not just in science, but in all the areas in terms of student learning, especially in the early grades. But even in the secondary grades, we're seeing the same type of education practice as being effective in our schools.

DR. BEERING: Dr. Ullah, what have you done in your area to showcase your best teachers to the community as role models to be emulated?

DR. ULLAH: This June we have -- in our district, we have science lead teachers, and we have science coordinators and department chairs and elementary school teachers. And this June, the district works with the Exploratorium in San Francisco and California Science Center right down the street. And we host a series of exhibits on the second floor there. And we're going to hold a citywide event, social event for teachers where city politicians and board members, and our superintendent will be there to honor groups of teachers. But most importantly, honor them all for the work that they're doing. And we're going to make that an annual process, and allow them at the same time to interact with the museum exhibits and have time there. So that's one thing that we're definitely doing to honor that. We also obviously stipend all of the teachers that do this work.

DR. BEERING: Dr. Valadez, you had another comment?

DR. VALADEZ: Yes. Thank you. For English learner students, opportunities in science, we especially need to look hard at the policies that

may contradict those opportunities for our students, and, in particular, whether it's adoption policies or policies on language acquisition from the federal, from the state, and in some cases, those that conflict. And because a lot of those policies are tied to funding, districts and the schools tend to follow the straight line on that language. And so we've got to be real cautious as we implement policy that they don't contradict what they know as best for kids, especially in the opportunities.

DR. VASQUEZ: But give me an example of the policies that you're talking about.

DR. VALADEZ: Well, in California, for example, ELD's, English Language Development, is now a curriculum that must be adopted at a state level, and it's devoid of science. And in some cases, they try to say English language students will access science through this language arts program, and there's no science. There's no conceptual flow. And in some cases, one example, they use a boy turning into a snake as being the life cycle. And, again, it's driven by that market that says, "We will have a publication for every need of our child." And so policies create opportunities, not so much for our kids, but for us.

DR. VASQUEZ: And no concrete -- nothing for them to develop those tools concretely at all outside of bringing --

DR. VALADEZ: Our instructoral day is so limited, and poor teachers, the burden is tremendous. And, okay, if we can't do anything about the policies and the constraints of the time, then lets look at where we can. After school and out of school, as we mentioned before, we really need to explore those opportunities and fund them well so that all kids have access and opportunity.

DR. BEERING: Let me thank this wonderful panel for sharing your insights with us.

(Applause).

And we have three more speakers that stand between us and a break and lunch. So let me invite Willie Pearson, Dean Gilbert, and Jody Priselac to come

forward.

Now that you have your name tags, they says they ain't nothing until I calls them, and I calls them the way I sees them. And now I see who's here.

Dr. Gilbert, will you start?

DR. GILBERT: Thank you very much. My name is Dean Gilbert and I'm president of the California Science Teachers Association representing over 30,000 science teachers in the state. That happens to be my part-time job. My real job during the day, I'm the science consultant for Los Angeles County Office of Education representing over 1.7 million students in this county.

Our main goal in California and our association is to promote quality K-12 science education in our state. However, there is considerable obstacles created by state policies. I'm hearing people talk about funding. I'm hearing people talk about inadequate teaching. But we have a serious problem of demoralized teachers, teachers that are leaving the profession faster than they're being trained. And a lot of this is linked directly to the obstacles that our state and I would probably venture to say many states are creating.

We claim to have world-class standards, yet teachers are told not to teach science in the elementary grades, particularly in grades K-3. But rather spend three hours on literacy and two hours on math instruction. This is in direct conflict with California Education Code that focuses on the four core subject area. Knowing that assessment drives instruction, we have a state assessment system that devalues science. For instance, our accountability tests in the STAR program, tests that evaluate a very small slice of science education at grades five, eight, and ten.

When I went to the National Science Teachers Association of National Congress last year, I was amazed at the other sister states, that at elementary, the fifth grade assessment is assessing K-5 science standards, whereas in our state we only addressed grades four and five standards. And as Dr. Strauss said, you know, if it's not assessed, it probably isn't going to be

instructed in the classroom.

Another thing is that the low-weighted value of science on our API obviously discourages any schools at focusing on science education. It just is not a valued subject in this state. We have policies and procedures in California for the adoption of instructional materials. And these policies and procedures restricts school choice rather than provide them with the flexibility that they need to meet the diverse learning needs of our students.

Because our funding at the state level is directly linked to an approved adoption list, those districts that determine that those instructional materials do not meet the needs of their constituents may be denied funding to purchase appropriate instructional materials. Those instructional materials would include hands-on, minds-on materials also. We need to have more flexibility for districts to be able to purchase those instruction -- instructional materials that meet the needs of their clients.

We also have a waiver system right now that is another obstacle, that many state or many school districts that find the need to submit more waivers, most of the waivers typically are denied. Especially if those waivers are requesting materials that involve hands-on, minds-on inquiry-based science. We seem to have an attitude in our state of a one -- a one type of pedagogical approach, and that is that direct instruction is the most effective, whereas those of us in the scientific community in California believe that whatever we add to a teacher's tool kit is going to be essential in order to meet those students' needs. It's not just direct instruction. It's not just hands-on, minds-on learning. It's getting into that tool kit and using what we need to be able to address our student needs.

It's also interesting to note that with the sunset of the Eisenhower funds, that there is no professional development dollars that is currently placed in the area of science education; that because it is a lump sum grant, most of the money is designated specifically for language arts and

math. We have had legislators that are currently putting in some legislative acts that our governor has vetoed. And the interesting thing is that we in the California Science Teachers Association, we get approached by many of the legislators that say, "What do you think about this legislation?" And there are so many weak points to the legislation that it's something that we typically can't support.

To be able to sit at the table and to be able to construct appropriate legislation that we'll need as teachers and students seems to be a more prudent way to approach it. We have a lot of people that are developing legislative acts that don't make any sense, and they never end up being funded. I had an opportunity about a month ago to testify at a JPL hearing by Senator Scott and Assemblywoman Liu. And, again, the conversations through all the panelists kept on coming up with it's a money issue. It's a money issue. And I believe it's not just solely a money issue.

I think that there are teachers that enter this profession not because of the paycheck that they get, but because they truly are interested in inspiring young people. And in L.A. County, approximately 60 percent of new teachers are leaving the profession within the first 19 months employment. And when I talk with these teachers, there is a level of discouragement because of the obstacles that our state is placing before them. They say, "Remove the obstacles. Don't treat us like robots. Don't create curriculum that has beyond a certain page, reading a certain thing, going through a certain set of standards on a certain day, and expect me to sidestep my creativity and my level of enthusiasm."

And many of the curriculum that is being approved by our state board is this type of curriculum. We've had a situation where our organization has advocated and lobbied against some of the things our curriculum commission has done because their attitude towards inquiry is that inquiry is wasting time. It's tinkering. Well, inquiry is what's developing the skill set that our technological workforce needs. Inquiry is what's developing the critical thinking skills and the problem-solving skills that our students need.

When I've been listening to the previous panelists talking about the importance of having a solid knowledge base, I talked with many of the UCC issue representatives, and they say, you know, "Don't worry about trying to send us these people that have a thorough grasp of science and math. We are getting people that don't have the critical thinking skills and don't have the writing skills and the computing skills." And it's not about having a deep, deep knowledge of science. It's having a love for science, having that curiosity to solve problems, and we're losing that in our system.

I think it's important that when you look at the workforce issue, they estimate that by the year 2010, more than half the technological workforce is going to be retiring. And we talk about focusing on middle school and high school. It's too late. If we're not teaching science in elementary, and if you look at the TIMSS Report, the NAEP Report where it says ask a fifth grader, students are becoming disinterested in science. We've already lost that. These programs that are being stripped from districts because of the policies of our state to focus on language arts and math is counterproductive.

So I really believe that when we start looking at how you can leverage at the national level, I think we need to look at bringing together the governors, looking at the secretaries of education that they are appointing. Making sure that they are equipped with the knowledge. For instance, there is research that shows -- for instance, Dr. Michael Klentschy, a superintendent at El Centro has an NSF grant where they have shown dramatic increases in language arts and math through the lens of an inquiry based science program, and that they made huge, huge growths in their scores, in their assessment scores through inquiry-based science.

And when those elementary students moved into the middle school level, because the middle school teachers were going back to read the chapter, ask the questions, and you'll have a test on Friday, parents were in an uproar. And because of parental pressure, they forced that same change

that occurred at elementary to then move into the middle school arena. So having these decisions to strip the day of science is actually challenging the good research that's being done out there in terms of how inquiry-based science promotes language development.

In fact, Mary Ellen Vogt, who is a researcher at Cal State Long Beach, who is in reading and language arts has shown that reading comprehension, the skills to increase reading comprehension almost mimic the science process skills. And yet we continue to see in the paper day after day after day state leaders that say, "It's all about language art. It's all about math," when science really promotes the language.

It's very, very concerning for me that -- as an educator who has never left the classroom, that still continues to teach, that we are sending the wrong signal. And the wrong signal is -- we do indeed have dedicated teachers out there. The teachers are getting discouraged. We need to focus on taking all of our energies and all of our efforts and focus on the people that are making decisions at the state that are counterproductive to promoting science education.

If you were to get instructional time that designates an equitable amount of time in science education and value science as much as the other subjects are valued, you're going to find that there's going to be a change in the quality of science education in the state. If science can't be taught, we can't inspire the kids, so we've got to be able to have the type of legislation that is going to lock in a definite amount of time to make sure that science is valued like all the other subjects. We need to push for legislation that has quality state assessment. The state used to have a good assessment program. It had justified multiple choice. It had the student writing about science. It had performance tasks. Now we're having filling in the bubble because it is more expeditious and it's less costly.

And I'll simply end with this. I think we need to approach our media. Our media creates the wrong image of what a science person is. We still have that image that it's for the white male. It's for

that nerd with the pocket protector. We need to have a national campaign to be able to promote science education to change that image of science. People think that science is destructive. They don't realize the contributions that science makes to their everyday lives. And if we don't change that, we're never going to move to a nation of becoming scientifically literate. And scientifically is not memorizing Mercury, Venus, Earth, Mars, Jupiter, Saturn, Uranus, Neptune, Pluto. It's about being able to go to the ballot box and make an informed decision that's going to affect the destiny of our planet. That's the charge of K-12 teachers, not 6-12, not 9-12, and not postsecondary. It's a commitment preK through post secondary. Thank you very much.

DR. BEERING: Dr. Pearson.

DR. PEARSON: Good morning. Willie Pearson. I'm currently the chair of the School of History, Technology, and Society, Georgia Institute of Technology. I'm also one of the past chairs of the Congressional Mandated Committee on equal opportunities in science and engineering. My presentation will focus on the importance of reducing the achievement gap and broaden participation of underrepresented racial ethnic minorities and STEM discipline and careers.

Math and science are of paramount importance in our increasingly complex and rapidly changing world. Yet the importance of social markers, such as social climates, gender, and ethnicity has not declined. There is a moral and urgent imperative that in itself expands its effort to develop home-grown STEM talent while proactively recruiting bright U.S. citizens from all backgrounds. In my view, the challenge to the nation's continuing economic progress, security as a tradition of the participatory democracy is the gap in achievement, separating disadvantaged and some racial ethnic minority students from other students.

Today, for example, the average African-American or Hispanic high school students achieves at about the same level as the average non-Hispanic white student in the lowest percentile of non-Hispanic white achievement. While there has been some

narrowing on the gap, progress remained marginal at best. Holding constant, for example, social climate levels of African-Americans, Hispanic, non-white students, roughly 50 percent of the variability in their performance can be explained by the competence of the teachers, especially their ability to promote higher art of thinking as discussed by the previous panels.

Reducing the achievement gap should be one of the nation's top priorities and building a better educated and skilled workforce and a scientific and technically literal citizenry. By the time some racial ethnic minorities students reach grade 12, they are already four years behind other students in both math and science achievement. Sadly, a 17-year-old African-American or Latino student achievement in English, mathematics, and science is at the level of that of a 13 year old non-Hispanic white student.

Approximately 31 percent of African-Americans and 24 percent of Hispanic high school graduates takes remedial mathematics courses compared to 15 percent of white and Asian students. The point being that we're still not doing well with everybody. Although college degree completion rates differ by racial ethnic minority groups and other groups, the gap narrows for college interest for those who have completed advanced high school courses and are well-prepared. Students who take advanced math courses in high school, such as trigonometry, precalculus, calculus are far more likely to earn a Bachelor's degree.

When African-American and Hispanic students do take advanced mathematics and science courses, they are less likely than others to complete these courses. In recent years, mathematics achievement has risen significantly in the earliest grades, including all time highs for African-Americans and Hispanic students. According to a recent nation's report card, the achievement gaps in reading, math between non-Hispanic white and African-American nine-year-olds and between white and Latino nine-year-olds is at all time lows.

Despite these improvements, however, significantly lower proportions of African-Americans and Hispanic students are proficient at each skill

level compared to their non-Hispanic white and Asian peers. Nationwide, Hispanic and African-American high school students are more likely than other students to drop out of high school. There is some element that students at risk from dropping out of high school can be identified as early as the 6th grade. At least four factors seem to be associated with graduating on time or at all. Low attendance, poor behavior, failing math, as we've heard before, failing English grades.

Here's a societal cause. I'm not addressing this issue. Dropping out of high school has debilitating consequences, not only for the individual and his or her family, but also for society, a cost that all of us may end up sharing. Annually, some one million high school dropouts cause this nation a staggering $260 billion in lost wages, taxes, productivity over the student's life span. High school graduation lowers the subsequent probability of incarceration of non-Hispanic whites by .76 percentage point, and for African-Americans by 3.4 percentage points. A mere 1 percent increase in the high school graduation rates would save the nation at least $1.4 billion each year in crime-related activities. An average increase of one year of schooling for dropouts will reduce the murder and assault rates by almost 30 percent.

What can we do? There remains a critical need for social science research to better provide understanding how to improve attraction, retention, persistence, and achievement in student disciplines and careers of all students. This requires collective and disaggregated data by race, ethnicity, gender, and disability status. For example, the factors contributed to underrepresentation differ considerably from one group to another. Only by disaggregated data can we effectively find solutions to reduce the achievement gap.

Many of the challenges that the nation faces in reducing the achievement gap and broadened participation in student disciplines and careers are social, and therefore are meaningful to corrective of action based on solid social science research. Few sociologists and historians of

science and technology have been engaging in the development of STEM curriculum materials that may be contextualized in ways that are far more appealing to all students, especially underrepresented ethnic and minority students.

Through formal and informal programs based on systematic research and rigorous evaluation, the NSF can continue to play a leadership role in breaking the hold in school cultures of underrepresented minorities and other economically advantaged students. There is evidence that widening achievement gaps in science and math are due at least in part to differential learning and retention of learned material during the summer. Research-based summer programs for teachers and K-16 students with rigorous evaluation components should be developed and implemented to help at-risk underrepresented minority students to retain what they learned during the academic year.

NSF must continue to place a high priority on broadened participation of underrepresented minorities and other underrepresented groups and not let the focus be mortalized in the broad category of broader impacts criteria, sometimes known as criterion two. In my view, NSF must hold a wide recipience (sic) more accountable for broadening the participation of underrepresented groups and student disciplines. I am cognizant that some of my concerns do not fall squarely within the mission of the NSF.

That said, however, I believe that the NSF can play a more proactive leadership role by partnering with other federal agencies, public and private organizations, for example, professional STEM authorities, retirement organizations, and social service agencies to reduce the math, science achievement gaps, along with racial, ethnic, and gender class lines.

Finally, underrepresented racial ethnic minority students deserve equitable access to challenging and meaningful academic experiences, because they are capable of developing the knowledge and skills to survive in the standards. That some progress has been made in there in the science and mathematic achievement gap in recent years suggests to me and others that the problems can be

successfully addressed through research-based interventions. Addressing these challenges will improve the quality of science and engineer enterprise, increase opportunity and entrepreneurship and promote the participatory democracy at home.

If the fastest growing jobs of the future require some postsecondary education, neither underrepresented racial minorities nor the nation can afford to survive in a globally competitive economy with current disparities in mathematics and science. Just as health disparities have gained public attention, so too must math and science disparities. The U.S. has the talent to solve these challenges. It must now exercise a greater notion of the will. We've seen in the past different reports, but now it's time for the nation to step forward with the will and to make certain at the local level that people be accountable for actually supporting the intent of this particular hearing. Thank you very much.

DR. BEERING: Thank you, Dr. Pearson.

Dr. Priselac.

DR. PRISELAC: Thank you. I'm very excited about being here today. The teaching and learning of mathematics has been near and dear to me for many, many years. As I began my career as a high school math teacher, I became a special development provider and now a university researcher. So today what I want to focus my talk on is a particular program that we have at UCLA about preparing math and science teachers and the lessons that we've learned from that and how this panel may take some of that to -- as they go forward with their task.

So to set the context, I'm currently the executive director of Center X in UCLA graduate school of education and information studies. Center X was established a decade ago with a vision to dramatically change schooling for the underserved students of Los Angeles. It provides a unique setting where researchers and practitioners collaborate to design and conduct programs that prepare and support K-12 teachers and administrators and urban schools particularly.

Center X programs are geared to teachers and administrators committed to social justice, instructional excellence, and carrying in underperformance schools. Center X has played a leading role in shaping and launching many programs in our city schools. We're committed to developing new knowledge, using it to improve education and make education more equitable.

In our center we have a preservice credential program, two Master's programs in urban education and principal leadership. We have a Ph.D. program actually funded by one of NSF's Center for Teaching and Learning, our diversity in math education program, as well as the California subject matter professional development programs. We have five content areas. I say all this because it's all of these pieces that come together to develop that -- that have come together to develop this program for training teachers of math and science.

Our teacher education program is a very small program, and it is highly specialized. It is a two-year graduate program where students leave with credentials and a Master's degree in urban education. The purpose, again, as with the mission of our center, is to provide high quality preservice education and radically improve urban schooling for California's racially, culturally, and linguistically diverse children. Each year we graduate about 200 students that go into the L.A. area to teach in our partner schools. Included in this large -- in this MP program is one that is specifically designed for math and science majors. So for this talk, I'm going to highlight that program.

This becomes -- we call this program the UCLA joint mathematics and education teacher prep program because it was originally designed with both the department of mathematics and education coming together, which is highly unusual, and it has been around since 1986, and it was designed specifically around the shortage of well-trained teachers of mathematics in L.A. city -- inner city schools. The program recruits juniors and math majors -- math majors when they are juniors, and we get them in schools right away.

We help them make sense of what they're seeing in schools by having a seminar both with a mathematics department instructor, as well as a school ed practitioner. So we begin recruiting in the junior year. In the senior year, they actually come into the graduate school of education, and they start taking ed courses and they start -- they continue to finish their degree in mathematics. In the summer, once they graduate, they take more ed course, enough to get the credential, and they begin teaching, full-time teachers the second year of our program. So they come out of school, go into teaching.

While they are in their first year of teaching, they are fully supported by the school of education field of people. As a part of this program, they do take a math methods course, again, which is a little bit unusual, but it's in the mathematics department taught by tenure tract faculty along with a K-12 practitioner. Following their graduation, getting their Bachelor's degree, again, they begin teaching full time and they work with the ed department as they do that. At the end of that year, they'll have their Master's and their credential, and then they become part of what we call our urban educated network. So they stay connected to the school, to the university because we provide them opportunities to participate in professional development activities.

So the program throughout that time in their junior, senior year, they actually receive funding. They get stipends so that they can work in schools that time rather than -- most of them need to have jobs in order to support their education, so we provide funding so that while they're participating in this program, they're able to be in classes and have some money to help with tuition.

So the key features of this program that we've been setting over the years is that, one, it was actually designed in collaboration with the Department of Education and the Department of Mathematics; that the field experiences of the students begin early and are extensive and are supported with seminars that help them make sense

of what they're seeing. Their education courses are highly focused around urban schooling and the kinds of challenges that they are going to face in the schools that they will be teaching in. They have three -- they are making a commitment to stay in those schools at least their first year so that these are the schools that they'll be teaching in.

They come with a rigorous math background, because they are math majors, and then they get their degree in mathematics. Their first year of teaching is fully supervised. They're not alone in the field. And as we've heard about the number, percent of people that drop out their first year, learning that support does indeed make a difference, and that they stay a part of the network; that their training does not end at the end of their -- you know, their credentialed program; that we have the opportunities for them to stay connected to their colleagues to feel a part of the community.

So the lessons that we've learned, because it worked so well with the math department in 1998, we then began a science component. So now we're doing the same thing for students, undergrads in the science school, that they begin participating in their junior year. Now, this number sounds small, and it is, and we are a small program. But by June of 2005, we had placed 280 math majors who are teaching in L.A. And, again, UCLA's program is pretty small compared to most of our student callings for our programs, but we still have one of the highest numbers of math majors teaching in city schools. We have 108 science majors now that are credentialed to teaching in L.A. city schools.

In 1999, 2000, we were funded by the Stewart Foundation to study our program. And so we've been doing a longitudinal study around retention. And we're learning that compared to -- we tapped into the NCES database. That database has about 10,000 teachers in it nationwide. And ours studies around 1,100 students. We have found that at the end of three years of teachers, that 90 percent of our students are still in teaching and in urban schools compared to the nationwide data which is around 67 percent at the end of three years. We are beginning to get disaggregate data so we have some preliminary data on our math and

science grads.

At this point, math grads, 83 percent are still teaching in our city schools. And that number is actually after seven years. And 90 percent of our science grads are still teaching in city schools. The other key piece of information that we are also studying is that at UCLA, through the Center X program, 98 percent of our early career teachers are both highly qualified as defined by the NCF study and are teaching in high poverty schools. High poverty schools are defined by those studies as well as being those with type one funds and over 50 percent of the students on free, reduced lunch. So 90 percent of Center X grads are highly qualified teaching in high poverty schools, while nationwide only 3 percent are highly qualified teaching in high poverty school.

The other piece that we are focused on is that one of the goals of our program is to mirror the diversity of our city. 35 percent of our grads are white, While nationwide 83 percent of our teacher are white. Some of the lessons that I'd like to point out from this program is, one, teacher preparation matters. And that's not a trivial comment. There is a trend nationwide to think that -- to support that notion that subject matter competency is all that counts. And if you know your math well, you can be put in a classroom and learn how to teach at that point. We're learning from this program that it does matter.

Teacher networks and support, learning to teach does not end with your first year of teaching, and that it is important in all our colleges around the continued support for teachers. And that kind of support needs to be embedded in their practice. And, lastly, I think an important point, is that until our departments of mathematics and science see teaching as a legitimate career pathway for their majors, that we're not going to see this change that Dr. Hoffman keeps asking us about, about what's going to change it.

So I believe strongly that we need to have programs that work with our departments in mathematics and in the sciences that help us in encouraging our math majors and science majors to look to teaching as a career.

DR. BEERING: Thank you very much. Let's open it for reactions and questions.

DR. VASQUEZ: One question with Dr. Gilbert, the El Centro project, which we know about, two things. I mean, you can point to lots of things that have helped make it successful, but two things that I know for certain is that they've had state funding; correct?

DR. GILBERT: Correct.

DR. VASQUEZ: And the second thing is they've had state administrative support. And so with those lessons learned in the time now that we live in where administrators move from place to place who don't have the sustained funding to do that, what other kind of things, what other success models do you see in California that might point to the same kind of success?

DR. GILBERT: Well, I think there's one other component about the El Centro picture that would be a major success, and that is Dr. Klentschy has done an excellent job in, shall we say, cloning people that have the same belief in science and people that will continue the process systemically. He's not a single person operating with this reform. He has teacher leaders. He has administrators that believe in this and support this. So even if Dr. Klentschy is transferred or moves to another district, I believe that it's going to be sustained, and I think this is critical.

When I look at the 82 districts that I serve in L.A. County, in which L.A. Unified is just one of those 82 districts, to kind of give an idea of the scope of L.A. County, the schools that are struggling, the leadership doesn't understand curriculum. They're site managers that may be good fiscal officers, but they don't truly understand curriculum. If they do understand curriculum, they've been somewhat bamboozled by the policymakers in the state that we have a two point agenda in California, and that's language, arts, and math, and therefore why should they bother reading the research of the El Centro story that validates that science and inquiry-based

science does indeed improve communication skills and math skills with students that are English learners. They have a tremendous population of English learning population.

When I look at other districts in L.A. County, the school districts that are really movers and shakers are establishing the infrastructure for change. It's not relying on a single person. The schools that continue to fall under receivership or problems of accountability are those that the site administrator has the vision, but cannot impart that vision to other people. So I think that that's a critical piece in systemic initiative. NSF continues to build into their grant the idea of sustained -- once the money runs out, how are you going to sustain this initiative? How are you going to continue to promote it? And most importantly, how can you empower that district to duplicate their model in other areas. I think that's where the ball gets dropped.

We end up -- we've got a lot of wonderful curriculum out there. But we are a society of procrastination and inconsistency. We don't utilize our resources to its maximum potential. And that's why it's not about buying more curriculum or putting more money into the schools. I'm not saying money won't help. But I'm saying money is not the sole issue. We need to start removing those state obstacles that are hindering, taking what we already have and moving forward with science education.

DR. VASQUEZ: Okay. One other question. Each of you talked about partnerships. Partnerships within industry, partnerships between the universities, the colleges. Do you think that that is one of the keys to making some sort of change within science and math education, is bridging those partnerships? I mean, what would you recommend if you -- does that --

DR. PRISELAC: I think it's absolutely critical. I think that's one of the lessons that we've learned from this project in the math department, is that without -- because it takes both. Content knowledge is absolutely necessary, but it's not sufficient in and of itself. So to me if we're working together and we see that as something

that's important to all of us, that that's the only way it's going to work. And so it's partnerships with the -- within the institution as well as then with districts that we serve in the community.

DR. PEARSON: I agree with Jody, because I work with a school system in North Carolina, and we've seen the same thing takes place, when you have the leadership of the community college, the local product university, the public university, but as well as the local industry there. They have done a marvelous job of trying to work together. And some of the banks there have worked with the preschool and some of the underserved populations, not only to provide resources, but to provide leadership. And I think that's been -- that's where everybody is on the same page. You can see the leadership moving forward, and the students take -- can improve and take advantage of that. But it also needs to engage the parents in part of the partnership.

DR. GILBERT: I would just like to add one thing. I do a lot of work with Boeing and Rick Stevens, is the vice president Boeing. They had a very, very strong partnership in the state of Washington. And when they found out that the school district were discontinuing the teaching of science at elementary because of language, arts, and math policies, the Boeing representatives went to the state superintendent and said, "You have two options. You can either reinstate science education in elementary, or we can remove our business from the state." And they reversed their decision, and now they are teaching science education.

So when you talk about what can this board do, business is important. Our state will listen to business leaders, and yet they will turn around and devalue the administrators and teachers that will go to Sacramento and testify. They'll listen to parents, but they won't listen to teachers that pour their hearts out and say, "We're giving it our all, but you are changing the target and moving it constantly on us. How can we expect to grow and move our kids forward?"

So, again, it's system. We've got to really bring

all of the resources together and really start tightening the thumb screws on people that -- I don't believe they're making these decisions out of bad faith. I just don't believe they're making decisions based on being well-informed. So I think that's really where we need to start using our energies and our passion.

DR. HOFFMAN: I promise to stop being a broken record and to address a different issue.

Dr. Priselac, your comments were so, so to the point. And, in fact, when Carl Wyman spoke in (inaudible) he said exactly the same thing. It seems to me that something that we really need to address is the fact that science and math departments at our best universities, at our science and technology universities, even at our liberal arts colleges do not value future scientists. And anything that any of you can do to help us make that point, to help us work with our science and mathematics and engineering departments all over this country to make teaching an important future profession for their students would be amazing as far as I'm concerned.

MS. PRISELAC: You're right. We are particularly proud of the relationship that we've begun to develop with our math department, and then the university systemwide is looking at a science, math initiative to help strengthen that relationship. And I think you'll hear more about that this afternoon from a couple of the speakers. But it is a really important part, because we can see that it makes a difference when we do engage faculty from those departments in helping us. So at our university, we have established a math ed committee that meets regularly to work on some of these issues. But it's big. We have 500 math majors out at our school, and 10 maybe 15, you know, come into our program.

DR. HOFFMAN: And I did that when I was provost at the University of Illinois, Chicago. Dean Stanley Fish and Dean Vicky Choo took the lead in trying to make that happen and found it was extraordinary.

DR. BEERING: Other comments. Tom.

DR. STRAUSS: Yeah, we've heard a lot this morning about STEM education in K-12, but there's been no education of the math science academies that a number of states have established. Is that because there are too few or is it because they're just a bad idea in terms of general education? Or is that not something that --

DR. GILBERT: Are you referring to high school academics?

DR. STRAUSS: Yes, Illinois, North Carolina, Massachusetts.

DR. GILBERT: I think in California and Los Angeles, we've got a lot of math science magnets that are very successful that are doing a wonderful job presenting rigorous curriculum, et cetera, but they still have to adhere to the policies of the state. And, therefore, if they have policies that are handed down to them, that will restrict the amount of science education and have them divert time to language arts and math. They have to abide by that. Otherwise, they're going to lose either state or federal funding.

DR. STRAUSS: Does that apply to the charter schools as well?

DR. GILBERT: Well, charter schools have more flexible, but yet most of them, at least the ones that I deal with in Los Angeles, it's interesting, here they have the opportunity to break some of the rules and slip through some of the bureaucratic cracks, but most of the charter schools that I see, they start with an innovative concept, but when they bring their teachers to the table, they revert back to a traditional approach to teaching, traditional curriculum, traditional pedagogy, and that's because our state sets aside three days of professional development a year.

Now, you've mentioned, Dr. Hoffman, about what can we do. I personally think that if this profession is going to change, it's going to need to be a 12-month profession where teachers are paid 12 months and where vacation is built into the 12 months, and a quality, sustained, ongoing professional development is built into their academic year in calendar and contract rather than

trying to have them come on Saturdays and put them in a dilemma where do I choose my family or do I choose my profession? Or to come and do a two-hour session after a eight-hour day of dealing with 200 students, and now they're expected to process content and do it with a one-shot deal when most research shows it takes a minimum of 18 hours of professional development before any behaviors change in the classroom. And the systems across the state don't practice what's being found in the research.

So unless we -- and, again, my colleague Jerry Valadez, unless we look at the system, the state system, the national system, and look at how education values the teaching profession, until some of these transitions change, I think we're going to be dealing with a lot of cosmetic fluff and a lot of rhetoric, and nothing is going to change, and that would be disheartening.

DR. PEARSON: Getting back to your question, I think one of the things that North Carolina, because I was there 20 years at Wake Forest University, and I know that the Math Academy did quite well, the one in Raleigh did, the school of math and science. But there also are other areas of excellence in the state of North Carolina. But part of these also dealt with partnerships. I'm on the Board for the Burroughs Wellcome Fund. They have a program that actually does outreach to the public school system. And that's been a wonderful program of providing resources, both in terms of funding, curricular materials, but they've also involved a number of schools that are low serving on low-participating kind of schools.

So I think even in that state, you saw the variability. And when you began to look at the school system working in North Carolina, you see within the discipline some schools performing quite different than the others, and you know that materials are different quite fondly. But we should not have a situation where a male child attending one high school has an 80 some percent chance of taking an advanced course and successfully completing it, and another student with the same kind of profile at a different school has only 15 percent chance. So we're still dealing with these inequities that we have to

address.

DR. BEERING: Other comment? I just want to observe that if we ran our businesses of America the way we do with K-12, we'd all be in Chapter 11.

DR. PEARSON: That's right.

DR. BEERING: I want to thank you for your very thoughtful commentary, and we are now ready for a break for lurch.

(Whereupon a luncheon recess was taken.)

DR. BEERING: Good afternoon for the discussions this afternoon. We're delighted to have President Priscilla Slade, RC Saravanabhavan, Denice Denton, and Eugene Garcia to start us out. We're looking, but someone down there is missing. Now we've got them all together.

Delighted to welcome you to the afternoon panels, and let us start with Dr. Eugene Garcia.

DR. GARCIA: Thank you very much. Much like the colleagues that have gone before me, let me thank the National Science Board for the invitation and the opportunity to express my issues, experiences, and concerns regarding STEM education in the United States.

Let me start with a little context. First of all, I know I was invited here because I am a dean of college education, and we produce individuals that I think are critical to STEM education in the U.S. But let me also point out that I'm a faculty member first, so I still continue to do my research, and I just finished an NSF project looking at science education in elementary schools, particularly with students who come from very diverse in ethnic and cultural backgrounds. So I continue that work as a researcher.

Also, I have to say as context, I spent some time in federal government, so I was in the previous administration, that is the Clinton administration in the U.S. Department of Education as the secretary, and worked, believe it or not, in the national science context, to try to bridge between

education and NSF and other science entities in the federal government.

I think lastly, as context, let me point out that I am a little kid from a rural area in the four corners of this country who got turned onto science and mathematics, and came from a family where you would expect that wouldn't happen. I spoke Spanish as the primary language. I was a migrant worker in that family, and would think that no one would ever think that I could be interested in science. And it turns out, thanks to a teacher or two in math and science, I really got interested in -- I think what I learned there later was sort of a pasture interest in science. That is, I wanted to know how we could learn about things that might actually help people. And so I might suggest, at least, that many kids are turned on in that sort of pasture way into science. How is it that what I'm learning about how the world works and understanding the theories of how that world works, how that might affect my life and my family's life and my community's life.

So having said that in context, let me bring to you from Arizona some good news and bad news about STEM education and education in general. First of all, like many other states, Arizona faces teacher shortages. We have a teacher shortage clearly in math and science, but in Arizona we also have teacher shortages in (inaudible) education, special education, and people certified to teach English language learners. 20 percent of our population in Arizona comes from homes where English is not the primary language and comes from schools where not speaking English is the primary language.

We also have a situation in Arizona where somewhere between 10 and 30 percent of our teachers teaching in areas are misassigned. They don't have any background in what they're teaching, yet they're still there teaching. Much of that occurs in math and science, but it's not only related to math and science. Lastly, we have teacher loss or as we call it we don't retain teachers. In a study that we did four years ago in Arizona, we learned that 40 percent of the teachers that are produced in Arizona essentially move out within five years of the teaching

profession. So that's sort of the bad news. We've got these shortages. We've got misassigned teachers. We've got people leaving the profession.

I guess the good news is that we can step up and try to address some of these issues. I went to Arizona State University because it did produce -- it was a major producer of teachers. In fact, it produces today 1,500 teachers per year. That's one of the largest number of teachers produced by any university in this United States and probably around the world. Four years ago when I finished that study, Arizona State was only producing 1,000 teachers a year. So we've increased production by 15 percent at Arizona State University in about three-and-a-half years. So that my point here is that a university can, in fact, improve its productions through its development of professionals. In education, make a difference.

What we've also done is redirect that teacher training to areas of greatest need. So that we are working in underperforming, underserved schools, those places where we have more teachers who are not certified to teach, but are teaching or who are misassigned and teaching. And we've been able by this targeted effort not only to increase the number of teachers, but to increase the number of teachers in those specific districts and schools and to reduce the misassignment by -- in some districts, in some schools so that now zero of those teachers are misassigned, and that there are no teachers teaching in an emergency credential role.

In general, we've also increased the exemplary teachers in those districts. Teachers again -- districts that are underserved are serving underachieving students. Many of you may be familiar with the National Board Teacher activity. We've increased by 50 percent the number of National Board Teachers in these districts and these schools. These are the exemplary teachers, the ones who really have to go through extensive review of their teaching in order to achieve that national recognition.

My overall point is can the universities, colleges of education respond to this kind of circumstance

in Arizona. The answer is yes. We've done that by redirecting resources. We've done it by going out and securing other resources, including private and foundation resources who have individuals who give scholarships, we've created incentives to give teachers who would not go into the inner city, who would not go into certain areas, and teacher credentialing created those opportunities through some sort of incentive structure. We call them scholarships, more specifically tuition, during particularly their student teaching experience. And we've created induction programs to try to keep those teachers once they're there so that we don't produce an expert teacher at Arizona State University. We produce an office teacher. And we need to continue to develop that teaching while they're there.

The bad news is that we have not done that at all in math and science. It's a different field. It's a different area. We can increase district production by 50 percent, but at the same time we were doing that, the bad news is that we were not able to increase production of math and science teachers. Five years ago, we were producing about 100 teachers of math and science teachers per year. Yes, last year, we produced 112 math and science teachers. It's a different -- it's a different ball game. So I want to point out to you that even though as universities can gear up, move their resources to produce more high quality teachers, moving into math and science is different.

Having said that, what is it that you can do to help us move from 112 per year to more than that, because clearly Arizona needs it. No doubt about it, the nation needs it. I think we need to provide incentives for partnerships. Clearly, across the university, we need to work as my colleague said this morning across the university with other colleagues in math and science and engineering. We have created with our own resources a center that we call CRESMET, which includes faculty in education, faculty in the sciences, and faculty in engineering. The direct intent is to try to increase now the number of math and science teachers that we're going to produce, because this is going to take all of us

to do that.

We cannot do it in the college of education alone. We don't have the content expertise. But the scientists and the mathematicians also need to work with us. I have to say the environment and the climate is soft. It's good. We're able to create that kind of collaboration. What you can do is help us create even more incentives for people to actually work together, the way we do in other kind of scientific areas. I think we need to create partnerships with the university and other outside university, certainly the (inaudible) sector.

Working with districts and schools we've been able to move teachers where they're needed most, and we've been able to draw teachers into those fields where they're needed most. We need to continue to do that, do it much more effectively in math and science. We need private sector. We've been very fortunate to have partners like Boeing, like Intel, like Motorola, and private films and other foundations that will supply scholarships and support. Unfortunately, only those individuals have supplied in the math and science area. I've got more people willing to give us scholarships for early child education and special education than I do in math and science.

So we really -- we are competing for a pool of individuals, and math and science right now is probably on the bottom of the list of many in that pool, including individuals who give money to the universities to generate good, high quality teachers. I think you need to help us by starting earlier. Clearly, a college earlier talked about achievement in math and science, especially for kids who haven't been achieving in math and science. We need to understand essentially that teachers need to have the skills to increase that achievement.

That's what we've been able to try to do together with our college through CRESMET, because even in Arizona, 40 percent of our young children in the elementary school come from homes that do not speak English as a primary language. About 60 percent of them also have -- are immigrant background. And then we're dealing with a first

generation challenge of individuals who have not experienced schooling in the United States, and yet we're asking them to step up to high standards, to excellence, et cetera, and do not have the support elsewhere, other than in the schooling process. So we need to realize who it is we're educating.

In Arizona, it's clearly -- the future of Arizona rests on educating those set of students who come to school who are poor, who may be from immigrant stock, and not themselves immigrants by the way. Most of them are citizens. They just happen to live with a parent or family that has come to the country as a newcomer, and many of those speaking a language other than English.

I think the two other areas I want to point out is we need to continue with research through the National Science Foundation, research in college that I and others have addressed. How do we really move good instruction in science and mathematics? How do we do that? Someone will argue, "Well, we already know how to do it, and we just need to do it." I'm afraid we don't know everything we need to know, and so I think it would be silly for the National Science Board to back away from issues that relate to doing good science with regard to this critical challenge.

Lastly, I would think to deal with this issue of induction. We cannot continue to have a revolving door and produce teachers, whether it's post-backs from the field who come to us from science and technology fields only to have them come into a challenging schooling experience and then leave within a short period of time. So we need ongoing professional development, particularly induction, to move them into the profession.

I think lastly I would point out too, since I'm wearing -- since I served some time in Washington, several of my colleagues earlier talked about NCLB and the Department's decision -- the U.S. Department's decision not to use science assessments in AYP. I have two ways to think about that. One is as someone indicated, if you measure it, it's important. The problem is we don't have a very good way to measure really how kids learn science and inquiry. Not whether or

not you can memorize the periodic elements table, but whether or not you really can think like a scientist, understand science the way we would like them to understand science.

Lastly, I would point out in NCLB their provisions for highly qualified teachers. Unfortunately, most states have been able to grandmother or grandfather in individuals in meeting that requirement, which do not really attend to the requirement that individuals have the content knowledge. So we do still have math teachers and science teachers who, because they have been teaching that for five to six years, have been grandfathered in, but don't know, don't really -- are not up to date on the content material that they're teaching. I think this is a flaw in No Child Left Behind, something that from a policy perspective I would ask that you address. Again, I appreciate having the opportunity to be here to get this in writing of course, but, again, thank you.

DR. BEERING: Thank you, Mr. Garcia.

Chancellor Denton.

DR. DENTON: Good afternoon. Thank you very much. I want to thank the National Science Board for this opportunity. Following Dr. Garcia's lead, let me situate my remarks with a little bit of context. I'm from Texas originally, and my grandmother was in a rice wearing (phonetic) family and never went to high school. My mother was a single parent with three kids and has been the cases for generations. Engineering really represented a ticket out for me to move into a higher quality of life. And I want to share with you a proposal for what I believe are three critical components of any effort to address science and engineering education in the U.S. to ensure that future generations and young people in our country have this opportunity.

So the first recommendation is a workable framework for engaging all sectors of the economy to work on this effort. The second is mechanisms to address the culture of academia, particularly in STEM. And the third is the transformation of pedagogy in science and engineering higher

education.

So to underscore these points, I believe that a nationwide initiative on the order of Kennedy's race for the moon catalyzed by Sputnik must be launched by the federal government to ensure that as a nation, we achieve excellence through our diversity. Unprecedented focus and resources need to be committed and supported by stakeholders including industry, nonprofit organizations, local, state, and federal government and every level of our educational system.

Regarding these proposals, the first critical component for reform is to adopt a framework that facilitates collaboration between government industry and academia. I believe that the Association of American Universities, AAU, has provided impetus for this through its proposed national defense education and innovation initiative. You can find that at www.aau.edu, and in the National Academy's report, "Rising Above the Gathering Storm, Energizing and Employing America for a Brighter Economic future." It's advanced that this nation must prepare with great urgency to preserve its strategic and economic security. And I really believe that it is urgent.

Clearly, the vitality of our economy is based on the productivity of well-trained people and the steady stream of scientific and technical innovations they produce. I urge that Congress develop and pass legislation that supports the NDEII, the AAU proposal. This unprecedented effort would at its core provide financial incentives for undergraduate and graduate students to produce STEM careers and it would include programs to improve teacher training and retention, like those that Dr. Garcia just mentioned.

At the University of California Santa Cruz where I am, we have an exemplar program for enhancing teacher induction and retention. Our new teachers center is a proven resource for new K-12 teachers providing them with mentors and support. The new teachers center's mentoring model adopted in 40 states and in other countries dramatically reduces the dropout rate among new teachers. Nationally, as you may know, the attrition rate is nearly 50

percent after five years for teachers. I think it happens actually faster than that depending on which state you're looking at. And by comparison, folks in the new teachers center program have an 88 retention rate over some of the time frame.

The second critical component I want to share with you is the need to foster cultural change in STEM departments in academia. Higher education institutions must create ways to accommodate and support a diverse faculty. At the top 50 chemistry departments out of 1,484 tenured track faculty, women represent only 167 or 11.3 percent. In the same departments, there are only 20 African-American, 1.2 percent, of which two of the 20 are African-American female faculty. These are all numbers that are from Donna Nelson's web site at University of Oklahoma, and she has data on the top 50 departments in many different STEM disciplines. The numbers for engineering department are even lower.

I'm very pleased that UC Santa Cruz has the highest percentage of women in Latino faculty in the UC system. 37 percent of UCSC faculty are women, including 34 Latinos, 18 African-Americans, 8 Native Americans, and 54 Asian-American. This inclusion is not done at the expense of excellence. In fact, to demonstrate that equity and excellence are synergistic, let me provide just two examples of academic excellence at UCSC in areas where women and underrepresented minorities are leaders.

In rankings by the prestigious Institute of Scientific Information, UCSC is No. 1 in the nation for impact of research in the space sciences, and No. 2 in the world for impact of research in the physical sciences. To achieve excellence through diversity, there is a need to cultivate change at the STEM departmental level at universities so that, A, all are welcome, and, B, all contributions are appropriately recognized. Currently, this is not case, and we must accept the challenge to foster change.

At a symposium on achieving excellence through diversity held at UCSC last November, Shirley Jackson, the president of RPI stated, "Diversity and discussions of it can be turbulent and

uncomfortable, but it also is clarifying, illuminating, leading to a deeper understanding of one's self and one's world. Diversity advances innovation. Diversity powers excellence." And Dr. Jackson refers to the issues that we're discussing as the quiet crisis in the United States.

During my tenure as the intermissionary at the University of Washington, I was the principal investigator on a NSF event, Institution Transformation Award. These awards support innovative and comprehensive programs for institutionwide change to promote the increased participation and advancement of women scientists and engineers in academia. I witnessed firsthand the impact of NSF's advanced program on addressing the challenges of establishing proactive methods for diversifying STEM departmental cultures. NSF needs to commit more funds to this program to share the lessons learned and to further institutionalize best practices beyond the small number of participating institutions. I have a lot of data as to the other events programs on results and impacts, and I would urge you to learn more about that if you haven't heard enough about it yet. Funding is also required for scholarly research that further informs and draws institutional change.

The third and final critical component is the need to transfer pedagogy in STEM departments and higher education. During the 47 years since Sputnik, there have been tremendous demographic changes in this country. Today 85 percent of the students at the undergrad level are women and minority students. The 2000 census (inaudible), for the first time California has no majority population, and of the 3,100 freshmen in the UCSC class this year, more than 1,200, 39 percent, identify themselves as underrepresented minority.

Past measures of attracting and retaining students do not work. Entry level physics engineering classes do little to explain the impact these disciplines can have on making the world a better place. This past week, the Duke Chronicle published an article from a student entitled, "Why I'm Not an Engineer." The female student noted that in her senior year in high school she was

voted, "Most likely to discover the meaning life through differential calculus." And after graduating with a Bachelor's degree in chemical engineering, she was now pursuing a Master's degree in public policy. She left engineering because it left her unfulfilled. Her statement, "Working at a chemical plant just does not lead to direct visible improvement of the human condition." She argues that, "These fields need to be marketed with more of a human face."

Many students, especially women, are leaving these disciplines not because of the lack of performance. They're due to frustration with current teaching methods and their wanting to have careers that will allow them to impact society and possibly humanity. Homer's research, talking about leaving, shows that the women students leaving these disciplines often have higher GPAs than the men students staying in the fields. It also shows that the students in general leaving the disciplines had GPAs as high or higher as the ones staying in the fields. So the mythology often on campus that we're weeding out the folks who aren't capable is really not reflecting the reality.

NSF can address this issue in part by providing increased funding for undergraduate research experiences that emphasize societal impact. For example, having students work with organizations such as Santa Cruz's -- UC Santa Cruz Center for Justice Tolerance in the Community gives them an understanding of how the sciences, quantitative approaches, engineering can be coupled with social sciences and humanities inside and outside of academia to positively impact the local community and engage them in research impacting environmental justice.

In conclusion, we not only must call for action on a national scale, we must be willing to be catalysts for change within our own institutions. We must reinforce the value of STEM disciplines in our society, and we must make careers in STEM both more attractive and more rewarding. At the University of California Santa Cruz, we are rising to this challenge, and we look forward to working with all of you in this crucial endeavor. Thank you very much.

DR. BEERING: Thank you indeed.

RC Saravanabhavan.

DR. RC SARAVANABHAVAN: Thank you, Mr. Chairman and members of the committee, for this opportunity to appear before you on behalf of the Howard University School of Education.

As you're aware, our university has been in existence since 1867 and has remained the voice of underserved subpopulations ever since. As we prepare future leaders for the nation and the global community, we focus especially in specializations in which African-Americans and others, other underserved -- other schools that are underrepresented. This proportionate representation of African-American, Native American, and Hispanic and Pacific Islander subpopulations in higher education is well documented despite steady increases in graduation rates of minority students in all kind of graduate programs in the last two decades.

The ratio of increases between the minority students and their white counterparts is significantly wider. In general, students of African-American, Hispanic, some Asian and Pacific Islander groups are less likely to successfully complete high school and enroll in college compared to white students even though there are not considerable variations in the likelihood of whites, African-Americans, Hispanics to enroll in science and engineering programs. The number of student joining college level science engineering programs has not increased in the last (inaudible).

In a rapidly flattening world, we cannot afford to be complacent. We need to constantly integrate the availability of our human capital, the quality of our workforce. We have in this regard identified the vital role educations has to play. Several efforts have been made to increase the number of students pursuing advanced level math, science and technology courses in high schools. Serious step have been put in place to improve the quality of teachers, particularly in the STEM areas. Higher education institutions have offered

additional scholarships to entice more students to choose majors in the sciences and technology. Yet, we remain short of realizing the goal of producing adequate math, science, and technology graduates.

Compounding this is the dwindling number of foreign students enlisters. Traditionally this group has represented a large percentage of science, math, and engineering graduates. Mr. Chairman and members of the hearing committee, I'm pleased to inform you that Howard University is acutely aware of this challenge to our nation and is playing a role in leading an effort to increase awareness, availability, and accessibility of the STEM education to students particularly from underserved groups.

A few examples in this regard are the giant projects between our school of education and the College of Engineering, Architecture, and Computer Sciences and our university's new initiative, the Howard University Middle School of Mathematics and Science. This is a sharpest public arts school within the District of Columbia. The school has a new academic model with a specific focus on mathematics and science. You know, we prepare -- the purpose here is to focus on students choosing science barriers or, you know, higher education.

The school has a longer school day with excellent instructional programs, a variety of after school enrichment activities. And these are developed university faculty as well as staff. The school also has small class sizes and active parent and community involvement in support of high student achievement.

Above all, the university by establishing and operating this middle school that will impact us has drawn attention to the critical shortage of African-American and other underserved students pursuing rigorous math, science, and technology course work. Also, it has garnered attention to the need for universities in metropolitan areas to demonstrate a commitment to improving this situation. And, finally, this particular school also offers the model design where local communities, parents, including university faculty and programs work together.

Another initiative, Howard University Center for Advancement of Engineering Education with partners in the University of Washington, Colorado School of Mines, Stanford University, and the University of Minnesota is paving way for expanding the community of leaders in engineering education, embracing diverse perspectives in research and teaching innovations, and increasing the number of engineering faculty who can teach effectively all students. And finally, also just helping to strengthen the engineering education research base.

Our universities also play a lead role in the environmental technology consortium of historically black colleges and minority institutions. And this consortium actually comprises 22 different universities across the country. And through this consortium we have played a major role to develop courses, initiate new graduate programs, such as new recruitment and provide training for K-12 teachers, as well as government industry employees.

Another noteworthy program is the Howard University Science and Engineering and Mathematics Program. We call it HUSEM. The goal of this project is to promote academic achievement, as well as increase the numbers of underrepresented minorities who receive Bachelor and undergraduate degrees in science, technology, engineering, and mathematics. A collaborative project between our school of education and the College of Arts and Sciences is funded through NSF. This particular project provides for a $10,000 stipend for eligible students to pursue a Master of Arts in teaching degree, followed by rigorous two-year, full-time work at a neighboring school district under the guidance of a Howard University faculty member.

Moving on to my specific recommendations to the committee, much needs to be done to even minimally achieve goals of building this human capital. An independent commission on STEM education is absolutely a step in the right direction. It's my hope that this commission would dutify (sic) the efforts of various federal agencies and facilitate a concerted implementation of policies,

procedures, projects to maximize this much-needed human capital. The commission may concentrate on the following issues relative to the four projected aims.

A recent Newsweek article profiled the economic achievement gap between males and females in general and the pattern of less number of male students at colleges and universities. Only 44 percent of all college students is male. One of the questions raised in this article was whether the definition of success should change. Many students seem to approach examinations differently from female counterparts. Also, methods of instruction, types of tests and testing appear to be more conducive to female disposition. Conversely, engineering and technology programs, as it was observed by a previous presenter here, seem to be tailored for males in general.

Continuous research and appropriate interventions in these areas are certainly worth pursuing. Continuous support for higher education institutions to regroup and sustain students from traditionally underrepresented subpopulations is also good.

Let me move on to my last recommendation here, which I consider very important. The commission may further pay attention to change the culture of a parent when it comes to learning science and technology. As a society, in my humble opinion, we do not insist hard enough to make all students to leave high school with sound basic knowledge and skills in mathematics, science, or technology. Countries which have naturally placed high value on mathematics and science courses, such as China, India, Korea, Japan, and many European nations obviously are at a greater advantage here. We have depended on a national -- an international crisis to promote the necessity to enhance and improve science and math education.

As a society, we all as one need to reevaluate basic subjects, the levels of knowledge and skills of children and youth required, not only to become competent and productive citizens, but also to function as highly knowledgeable, humane, and global persons. We should promote different groups of floor models. Our scientists and Nobel

laureates deserve public recognize and admiration at least at the same level as our sports stars and corporate leaders. Thank you.

DR. BEERING: Thank you indeed.

Now President Slade.

DR. SLADE: Thank you, Mr. Chairman and members of the committee, for allowing me the opportunity to speak with you this afternoon concerning a topic that is of increasing importance to everyone in the country. I would like to give you a little background about the university as well and then proceed by speaking to one of the questions that you raised in the documents that were sent to the university and offer up recommendations as a result of that.

Texas Southern University is the second largest historically black college or university in the nation, and it is also the most western historically black college or university. We're the closest to California. As an open enrollment institution designated by the 63rd Texas legislature as a special purposes institution for urban programming, TSU is keenly aware of the disparities in the STEM participation when comparing students from other countries to the United States, students in general, and African-Americans and Latinos in particular.

And the question that I would like to address is why do the recommendation and alarms of previous reports and statements from eminent bodies of academic, government, and industry leaders seem to have been largely unanswered? As you know, the lack of STEM prowess in the United States has much to do with international interplay. Numerous academic governments and industry-oriented reports, as well as your own report, the National Science Board's Science and Engineering Indicators 2006 support this statement. Yet, these academic reports or opinions are only as significant and useful as the country's agenda which fuels them.

Indeed, these respects provide facts, they provide the current state of condition and forward-focused solutions relatively to enhance educational programs, but if they are considered as an

afterthought rather than a priority, particularly in cases of funding and resource, they will remain largely ignored. I believe that the lack of a reciprocal outcry or demand for action to these studies and reports by the general population is basically the result in large part due to the fact that America might just be a little bit in denial.

As the world's super power, we have leveraged substantially the connotation of this title. We firmly believe in most cases that we are the -- we are leading edge in areas that maximize access and opportunity and quality of life as it relates to technology, business, and economics, medicine and pharmaceutical research, agriculture and food, and of course, education, but yet as our world grows smaller and cultures and systems of industry are better connected technologically, many countries such as China, South Korea, and India are placing priority on educating more scientists, more mathematicians and more engineers.

As in the NSB S&E indicators 2006 report, you state that more than 9 million students worldwide earned undergraduate degrees with more than 3 million of these degrees in science and engineering fields. Asian universities accounted for at least half of that in 2002, and more than 600,000 of them were in engineering. Students across Europe including eastern Europe and Russia earned about 930,000, and students in Northern Central America earned nearly 600,000 science and engineering degrees in that time period. But yet, instead of increasing funding and directing appropriations to programs that grow, increase and retain STEM talent in this country, more and more we are cutting and/or redirecting those funds to address other priorities.

So while these regions are placing education as a priority and training a younger workforce, what we're left with in America is a lack of investment in STEM aptitude and aspiring students and professionals and a failure to address comprehensively the inequalities in our public schools across the nation. Updates and reports are wonderful. We need data in order to guide our decision processes. But updates are reports that just sit in web site repositories are just not enough. We must inspire the will of the community

to underscore the dire straights we find ourselves in relative to producing sufficient mathematicians and scientists, engineers especially within our underserved populations.

So what does this predicament that we find ourselves in cause us to do? We need basically a grass roots catalyst. A grass roots catalyst that could, No. 1, focus essential attention on some of these special reports at a community level comprising specific roots or targets, African-Americans, Latinos, everyday working citizens, populations in the poor state.

No. 2, we need to mobilize reports. They're not good enough sitting on the shelves. We need making them not only accessible to various communities, but also understandable and relatable. Now, I am an account -- in fact, academic preparation. I might be able to muddle through one or two. But the individuals who are really responsible for the implementation and making a change and making a difference, they need to be able to understand and relate to the information that's being provided to them.

No. 3, forge a call to action to press upon local and national elected officials the grave importance of making education in these areas priority, including increased academic participation by teachers and student, funding, job placement, and mentorship programs, industry benchmarks and best practices.

And No. 4, we must cross-pollinate. There are a lot of lessons that we have learned that we can share. I've heard a few of them here at this table today. And I have a number that I can even share which center on accelerated math, science, and engineering instruction. We must begin to reach people where they live, and we must work collaborative in finding solutions relative to broadening STEM achievement. Now, I'd like to give you just a little idea of what the State of Texas and Texas Southern in particular are doing to address this critical issue in our country.

In Texas, legislators are focused on this issue, and they are -- we have actually set aside a $71 million Texas STEM program initiative. This was

created by our governor Rick Perry in collaboration with the Texas Education Agency and the Texas High School Project. What this initiative essentially does is create academies and training centers that focus on STEM areas in grades 6 through 12. Each grade will enroll only 100 students to sustain focused, personable learning settings. And by 2007, it is intended that 15 academies will open. And by 2011, 35.

Students attending this Texas STEM academy will be required to take four years of math and four years of science. In addition to these learning academies, the legislature passed House Bill 1144, which offers math educators assistance such as student mathematics diagnosis, professional development, Master mathematics teacher certification, research, after-school and summer intensive mathematics instruction programs. So the legislature as well as the governor in the State of Texas has made STEM education a priority.

At Texas Southern, in particular, the college of education established a collaborative relationship with a national alliance of black school educators. The goal of this initiative is to make available the best practices, approaches, and philosophies of high achieving schools in public school districts. We want to make these approaches available to the decision-makers in these districts across the country in an effort to directly curtail the 7th through 10th grade dropout rate.

In addition, the Texas Southern University Math and Science Academy at Jones High School endorses the community out reach division by becoming involved in the national education reform to lessen the academic achievement gap suffered by underserved students. This initiative is funded by the Gates Marshall Redesign Project. The goal of the program is to literally transform Jones High School into a high performing small learning community.

Texas Southern University promotes this goal by advising a core group of the instructors who will follow participating students throughout their four-year course of study at academy. The program focuses on the four-year math and science

curriculum and helps the students to view characteristics outside of academia that would be conducive to success.

We also have a teacher quality mathematics program, which was recently awarded to one of our mathematics professors. The college of education is assisting in this grant program that will strengthen the math instruction skills of soon to be high school students.

And last but not least, we have at Texas Southern the Lewis Stokes Alliance for Minority Participation Program. This is a partnership among many of the universities that reside in the City of Houston, University of Houston, Rice University, Texas State University, and several of the community colleges as well. With this program, we have significantly increased the number of students that are majoring in STEM fields from the participating universities.

The profile of these students that are entering this program is very impressive. They have average GPAs of at least 3.6. These are national merit scholars, valedictorians of their high school graduating classes, who's who in American high school students. 95 percent of them are involved in some or all of these types of activities. And these students are aggressively recruited. This program has been tremendously successful in the Houston area.

Texas Southern University and universities across the country have the capacity to inspire a dynamic call to action within our respective communities relative to optimal STEM and overall academic achievement. We have the capacity to assist in facilitating partnerships with businesses who stand to benefit directly from students majoring in these fields. We have the capacity to partner with governmental agencies and produce the kind of programs that will advance enrollment in STEM areas.

Our recommendation, then, not only would be to begin with the grass roots and start a groundswell of efforts within the community, but also to establish a national vision for STEM education at all levels, the secondary school level,

postsecondary school level, and have well-defined goals and objectives determining -- well-defined goals and objectives that will enable us to get to the ultimate goal, the end product, which would be to increase participation in STEM fields.

And most certainly the data that is already provided in this area would guide any vision, any goal, any objective that would be established in this area as well as any of the best practices that have already been described at this table and that exists in universities around the country.

DR. BEERING: Thank you very much indeed. Reactions?

DR. VASQUEZ: Dr. Garcia, fellow Arizonan. The ASU modelling program, are you familiar with that at all? It's out of the physics departments. What other kinds of partnerships have you formed within the community? You talked about your study on elementary science. I would be curious to know a little bit about that and maybe some other partnerships within districts.

DR. GARCIA: The largest partnering entity in ASU is CRESMET, so that there is specific -- particularly with Mesa, with Tulsa high school districts and high schools along with other elementary middle school districts to do professional development in math and science so that that partnership exists essentially with teachers working with individuals in math and science, professors at the university in conjunction with colleagues in education for more pedagogy. So I think that is an example of our broader areas in math and science.

With the Mars project, which has a set of partnerships in public schools in which families and teachers and kids can actually be involved and manipulating and asking questions about data generated from that that expedition through the college at ASU. Those are the kinds of partnerships that link our science and math colleagues with the (inaudible). Those are the kinds of partnerships we're trying to essentially evaluate and expand quite honestly. None of them really deal with production of teachers. Most of them deal with the professional

development of those individuals in the field.

What we're trying to do is sort of change the direction. We need our colleagues to be involved in the production. I mean, one of the -- again, the sad news is over a five-year period where we increased teacher production, we did not do it in math and science. We were busy doing work out in the field, but not busy producing new teachers. With partners like Boeing, which is very (inaudible) with Mason, but with other partners like Intel and Motorola, we are, in fact, able to generate now some new energy around this issue, much thanks to the kind of attention you and other colleagues are giving us.

DR. VASQUEZ: President Slade, tell me about the AP incentive program, and has that made any kind of a difference that you've seen within Texas as far as the students coming into Howard or any of the other universities?

DR. SLADE: The AP?

DR. VASQUEZ: The AP incentive program that the O'Donnell Foundation has been funding. Are you familiar with that program at all? It's where they've increased minority students to go into AP classes or to take AP classes with an incentive for the teachers and for the students.

DR. SLADE: I know that in the State of Texas, there is incentive for students to take more math and science courses. As a matter of fact, they're able to get funding from the state in order to pursue their college degrees as a result of that. I don't know if that's what you're referring to. But there is -- there has been a very strong push on the part of the governor as well as the legislature to get more students involved in STEM areas.

DR. VASQUEZ: Okay. Last question, and then I'll turn it over to Betsy. You mentioned -- and I'm going to say it wrong. Dr. --

DR. BEERING: Dr. RC?

DR. VASQUEZ: Yes, Dr. RC. Tell me about Go Lumberjacks. You said that you gave $10,000 for

their Master's degree, okay. My first question would be: Is that enough? And did any of you envision a program where a person would go in and get a teaching degree and be forgiven of that debt with their Master's? That wasn't made very clear there. But they were able to get their Master's. They have a degree in math or science. They were able to get a Master's in teaching, and that that debt would be forgiven.

DR. RC SARAVANABHAVAN: This is a five-year program. Our scientists have first the content area course work. They do math, biology, and then they join the school of education where go they go through the pedagogy.

DR. VASQUEZ: Okay.

DR. RC SARAVANABHAVAN: Following this, replace them at the schools. This is an NSF grant. And that way, $10,000 is not adequate.

DR. VASQUEZ: Let me increase that. $10,000 is a drop in the bucket.

DR. GARCIA: Our direct experience at ASU is that during the time we increased one of the teachers, we did have increases by threefold the number of scholarships, the amount of scholarship money. But that wasn't enough to bring more people into math and science. It was enough to bring in early child and special education.

DR. VASQUEZ: But not math?

DR. GARCIA: Not math and science.

DR. HOFFMAN: I just wanted to reiterate a comment earlier. I really think one of the key issues we need to address is how to get the math and science department chairman, chairperson, faculty at our major universities engaged in this with our colleges of education or in partnerships with other colleges of education because many institutions like small liberal arts colleges, like the institutes of science and technology don't have colleges of education, an opportunity for the science teachers to engage in the recognition that the future of our country depends their properly preparing science teachers.

And I don't have -- I certainly don't have the answer. It's something I've worried about for a long time. I think that any -- that you folks are going to talk next, because I know some of the next group is going to talk about this as well, anything that -- any ideas that we can get about how we as the National Science Foundation and the National Science Board can provide incentives for departments of math, science, engineering, and the hard social sciences to take seriously the need to prepare future teachers.

DR. DENTON: I want to make one comment that I really agree with. The engineering community of deans has met periodically with the deans of education, and so NSF could fund subsequent conferences that bring STEM deans and education deans together. And the second way, the obvious way is to have more RFPs coming out of NSF that encourage and catalyze those partnerships in any number of NSF wide systemic reform or, you know, innovative, leading edge science efforts cross-cutting, as they call it in NSF, to ask that all the players be at the table when these proposals are put together.

DR. SLADE: I would agree with that. Dr. Hoffman, one of the -- you can't get around the idea of incentivizing actions that you want to see. Individuals are motivated by incentives to do --

DR. HOFFMAN: I'm an economist.

DR. SLADE: Good. We speak the same language. And most certainly getting -- not only getting them together, but we need some well-defined objectives for them coming together. What is it that we want to achieve as we bring together these deans of the various colleges, because they all have their own separate agendas. And in order to -- there has to be a global agenda for them coming together, and incentivizing that global agenda, I think, would get the desire itself.

DR. DENTON: I would add just one more thing. A couple of months ago there was a meeting in D.C. sponsored by NSF, NIH and the Department of Energy, I believe, and it was on gender and chemistry in academia. And it brought departments

from around the country, leaders from the federal agencies, Chuck Vest spoke, Senator Widen and others, and there were clear goals and outcomes desired from that meeting. And that could be a model for other kinds of areas that they're cross-cutting to this topic we're talking about today.

DR. BEERING: I want to thank you for your cogent observations and thank you for participating. And let me call on the next panel of McDermott, Stage, and Thier.

DR. CROSBY: And if I could remind the next panel that the comments are kindly requested to be limited to five minutes. Ms. Englert, when she stands up over here to the side, it isn't just for her exercise. She's letting you know that you're getting close to your five minutes.

DR. BEERING: All right. I understand you have colluded on the order of the march.

Dr. Thier, and then Elizabeth Stage, and Lillian McDermott.

DR. THIER: Yes. I was told when I was supposed to speak. And having lived many years with a strong and delightful wife and three daughters I pay.

DR. BEERING: Do you have a male dog at least?

DR. THIER: No. I have two male grandchildren.

DR. BEERING: Very good.

DR. THIER: I appreciate the opportunity to speak to you today and hope when I'm done you will also appreciate my comments. For over 50 years, I've had the privilege and the enjoyment of being a science educator and school administrator. My goal had always been to provide all students with challenging opportunities to learn science and how to apply the evidence-based approach of science to decisions in their daily lives.

As requested, I will focus my comments on the areas where I have gained particular insight or experience primarily through my experiences over

40 years in leadership of instructional materials development and teacher enhancement projects primarily funded by NSF. NSF can continue to improve the quality of K-12 science education. And I use the word "continue" because I really think we need to be very careful to remember all that we have accomplished.

In 1962 I was an Assistant Superintendent of Schools in Falls Church, Virginia. I was asked to make recommendations regarding the science textbooks for the state of Virginia. There were 24 of them. One had a kit that was suggested, not required. A number of years ago before writing another NSF proposal, I surveyed all the science programs offered for the elementary schools at the National Science Teachers Association. There were 23. Every one of them had a kit. I am not talking about the quality. I'm talking about the fact that a change had taken place in what was thought elementary science should be. I'm disappointed that we've lost a lot of it in the last few years.

Therefore, I also want to suggest that my two interests are one, the materials that are used in the classroom, and with the guidance of a competent teacher, form curriculum. The curriculum is something that happens between human beings. It is not something on paper. I also want to bring up the fact that nothing of quality will take place unless we find increasing ways to give leadership to the best of our teachers, and focus on recognizing that percentage of our teachers who are doing such an outstanding job and give them leadership opportunities in their own schools without having to lose.

Before going on, I would like to briefly talk about what I think science is and what I think it isn't and the concept of learning. Science is a way of asking and seeking answers to questions, rather than learning answers to someone else's questions. Learning selected facts and the results of the work of others is necessary, but not sufficient for the kind of deep understanding we want for our young people because I don't know what topic in science will be important when they are adults.

Secondly, there is nothing further from the procedure of the scientist than a rigorous, tabulated progression through the supposed steps of the scientific method. And for those of you who don't believe that, I strongly recommend John Rudolph's article in the fall of 2005, "Journal of Higher Education."

I also want to suggest to you that there are three principals of learning as put forth briefly by Fosters & Masters in a yearbook I had the privilege of working on. One, teachers identify and work from learner's current knowledge and belief. If you can't get the student engaged, you're not going to teach them anything. Secondly, learning result in well-organize knowledge and deep understanding of concepts and their applicability. It's not how many things you can bring up. It's how many the students want to remember. Third, learning is enhanced by the ability of learner to monitor his or her own learning. That is a function that is rarely thought about.

We need to take an evolutionary approach to science standards in the 21st Century. Too often in science education, we take the revolutionary approach. Someone gets funded. They throw out everything that's been done before and start anew. We do not usually throw out babies with the bath water. I don't do that with my new grandson, and I strongly recommend we give it up in science education.

The National Science Education standards, except for the content standards, are an excellent guide to where we need to go. For example, I would suggest that accomplishing the approaches emphasized in standards defined in the Teaching and Professional Development, chapters 3 and 4 of the standards, are absolutely essential. Every R and D proposal considered for funding should be required to specifically explain how they will contribute to further those student standards.

Unfortunately, I don't think the same of the contents standards. I think the contents standards need to be totally rethought. They're an enormous step forward from what we had before, the huge laundry list, but unfortunately, the

current context standards are not up to the 21st Century.

First of all, we need to have content standards that define what students need to know and, more importantly, understand and use as fully participating citizens. We need to encourage students to make science and technology career choices. Pipeline and general education concerns are meaningless in the 21st Century. The only nonscience and technology jobs available are the ones you don't want your children, grandchildren, or anyone you like to have. That's not the nicest statement to make, but it's true.

Next, artificial categories such as biology, chemistry, and physics where you pay your dues as a professional are worthless as a basis for defining science education. We need to step back and ask the question of what is science in the 21st Century. As a number of people and technology -- as a number of people have alluded to, science technology in the 21st Century are cross-cutting. They involve all -- many of the disciplines at the same time. We need to go into science, identify what are the fundamental concepts in science, find out how to achieve a goal we want, and then encourage ways of teaching to those standards.

I want to suggest that the -- that assessment is a very important part of this. We need to have significant thinking of what we mean by assessment. Today we tend to focus all of our assessment resources on things that we can measure easily, facts, by using a machine. We need embedded authentic assessment, as I have gone into in some detail in my submitted remarks.

I would like to end with five recommendations that summarize what I am saying. First, further development of quality science materials needs to be evolutionary rather than revolutionary. A lot has been learned, and it needs to be used as a basis for further change. The instructional leader in the classroom is the teacher. And increased thinking and resources need to be focused on how to help the teacher become more competent as a facilitator of learning. The content standards need to be revamped and

rethought from the 21st Century point of view.

The involvement of many federal agencies these days besides NSF in science education with many agencies required to have education in part of everything they fund means that we need to find ways to better bring together all agencies in the federal government working on science education so that we have a concerted, organized, thoughtful approach rather than a discombobulated approach.

Last but not least, assessment as is currently practiced in the schools needs to become a learning experience for students and teachers. Embedded unauthentic assessment that leads to feedback that informs future instruction experiences needs to be emphasized. Yes, I am concerned that no child is left behind. I'm even more concerned that all children have the opportunity to move ahead. Thank you very much.

DR. BEERING: Thank you indeed. You have the stage.

DR. STAGE: Thank you for inviting me. At lunch Dr. Beering suggested I tell a California joke. The periodic table of elements is in the third grade standards. That's an extreme case of saying what the public understanding of science is. And being truly passionate about the periodic table, I think that many people in California think that having the periodic table in the third grade shows that we're really serious about science. I think the public understanding of science and a public campaign to get the attention of parents and school boards is sine qua non for having a national commission. That's the punchline of my remarks.

I applaud your publication of this education companion to the scientific ears. I think you're trying to focus public attention on important issues in STEM education. And rather than agree with everything you said and many of the preceding panelists, I'd like to pull out some ideas that I think need particular emphasis. One is the concerns about the declining interest and achievement from elementary to middle to high school to undergraduate levels is understandable but misses the point that the pipeline starts at

elementary. And with all due respect, Dr. Hoffman, I think a lot of talent gets taken out of science and science teaching in the freshman and sophomore years of the undergraduate program. So I think a lot of the best and brightest are looking at the nature of science in the lower division and saying that there's a better way to have a positive impact on the world as many of us said.

But anyway, a number of people have talked about the testing preoccupation with reading and math. The policy evidence I'd like to say for that is in the very location where we sit, the second largest school district in the United States. Reading the science selections in the basal reader is the Board's mandated science program. Now, there are a lot of people in this area who are getting away with murder by doing the right thing. But we shouldn't be putting teachers in that position.

Now, Dean Gilbert said many things about the California policy, with which I agree, but you're probably asking yourself, "What can we do about these misguided people in California?" What you can do, and several people have mentioned it, but I'm going to say it in a very pointed way, is stand up for good assessment. The education human resources director at NSF has funded a full portfolio of high quality assessment projects, and they are having a full-day symposium here in Los Angeles in conjunction with the national meeting, and it's awesome.

But a nation that's willing to pay $40 to find out if a child has strep throat, which is a really easy question to answer, is not willing to pay 15 to 25 bucks to find out how a kid is understanding science. So you denigrate the science to make it cheap to test. Not just easy. Cheap. And with all due respect to Dr. Garcia, we do know a lot more about measuring kids' inquiry abilities, but we have to pay for it, because machines cannot yet detect the ability to argue from evidence.

So this tradeoff between science and literacy development, I think, is misplaced. It's a smaller portfolio in education and human resources. El Centro has been mentioned, EDC has a program, Lawrence Hall Science has a program.

There are a lot of promising approaches about developing language and science in the elementary years. And so if you adopt the challenge language in the president's budget, which would be worth a discussion in and of itself, I would say that language and science development at these critical elementary grades would be a grand challenge.

And there's a lot of seeds of activity around the country that rather than having the principal investigators compete for the one grant that's going to be given for ELL kids this year, to actually work in a concerted way as a national center on that issue I would strongly recommend. Many of us have mentioned the achievement gap. I'd like to reiterate the point that the more thinking and reasoning there is on the text, the bigger the gap. You can divide that United States into two countries, and the distance between the underrepresented students and the non underrepresented students is as big as the distance between the United States and the toughest growing countries in PISA.

Add in AP exam scores, add in actual dropout rates, and we're talking about two countries. One that's still competitive, and the other one that is decreasingly competitive in the 21st Century. What can you do about such an intractable problem? Dr. Pearson has said that there's a lot of scholarships that could be brought to bear, but I think that hiding it under low level tests exacerbates the problem, and I think that it hits very few policymakers.

Boards of education, politicians, and those folks are in the half that's getting something, and they don't get the relationship between the haves and the have-nots and their economic security and frankly national security. And I think it's a compelling message and should be crafted, and I think the Board is in a position to exercise that leadership.

I want to make one more point. Nicholby, yes, put science in the adequately yearly progress only if it's tested well. Don't bother if there's not accountability for the quality of the assessments in my personal view. Why is this night different from all the other nights? Wasn't all this said

in 1983? Yeah. The Board talked about high quality. The nation at risk talked about a lot. Take more classes, four more minutes, more courses of preparation for teachers, more, more, more. That's easy, and the states and locals had to pay for it, not the feds.

As Cecily Selby testified to you in Washington, if you're ready to back up some really expensive ideas, go for it. If you're going to try to do it cheap and pass it on to the states, forget it. It's not worth the time and the money you'd have to spend." So the first '83 commission report was build a strong and lasting national commitment to quality for all. The need for leadership has never been greater. Science itself is challenged by political and religious conversations that were unthinkable in 1983, and discussions at local and state boards of education are even more challenged in those ways, more time spent on intelligent design than any other science issue.

So if you're willing to be in there for the long haul, I think there's a tremendous amount of enthusiasm among the business community, among scientists, among educators that we rally together, take advantage of Thomas Friedman for goodness sakes, have a huge campaign that raises awareness of what science is and why we all depend on everybody having a better understanding of it. Thanks for the opportunity.

DR. BEERING: Thank you so much. Dr. McDermott.

DR. McDERMOTT: Hi. I'm a professor of physics at the University of Washington, and I notice I'm listed as the Director of the Physics Education Group. I'm not really a director in that sense. I get that title because I've had NSF support over many years, and I'm a director of projects. So I'm approaching this in a much more narrow way than my colleagues. I wanted them to go first because they said the things I won't have time to say. I agreed with almost everything that was said. One small point, and we'll get back to that later:

I want to -- now, what I'm going to say, because of the time constraint -- and I won't hold forth the most topics that they've addressed. There are

a number of ways NSF can make a difference. And what I want to speak about is the one with which I've had direct experience, and it's probably not addressed by anybody -- has not been addressed by anybody else. I know that Carl Wyman and Leon Letterman talked about ideas in physics education. They have a Nobel Prize, and they went to it afterwards.

My whole professional life has been directed toward the preparation of teachers of preservice and inservice and research into how students, including undergraduates and graduate students, as well as preservice and inservice teachers, what you can do to make a difference. And so what I would like to do is say that -- if you want to summarize, that in K-16, K-20, K-20 plus for some of us, instruction, and I want to set what I want to say in terms of what we've done, not because it's the only way, but because it is a model.

Our group conducts a coordinated program of research in the learning and teaching of physics. The development of curriculum based on that research in which assessment is an integral work and instruction in the classroom. Our work encompasses the education of undergraduate in preparation of preservice, inservice, K-12 teachers to teach physics in physical science by inquiry and the professional development of physics graduate students as future faculty.

I should mention, again, thinking about what NSF can do, in a sense, what it did was help me get where the group and I are today. Our students get their Ph.D. in physics not in physics education, research on the learning and teaching of physics. And our faculty, which as you probably recognized, is one of the top-graded research oriented physics departments in the country has accepted this. And the reason they have accepted it is because we have done what they do, careful research, documentation, publication, writing proposals, and being fortunate in NSF to -- to NSF, well, this, getting funded.

And they respect that because, although in the abstract, they never would have accepted this, when issues of promotion came up, they look at, "Okay. What do we expect? Publish repair. What

do we expect? We expect to get funding. What do we expect? Talks and things of that sort." About 20 years ago it was unusual for someone to get up in the physics colloquium and talk about learning and teaching physics. Now it's happening all over. And, I mean, I'm not the only person. I've mentioned others, and it's happening in several places.

But there are a number of institutions and universities besides our own that have programs in the physics department on learning and teaching of physics as a worthy field for scholarly inquiry. Now I want to also mention that students in our group take all the courses, all the qualifying exams, and everything else you do if you're a physics graduate student, and That's what gains respect. And I'm coming at it from a little different perspective. How can you make a difference in academy departments? The culture is very different from education.

One of the problems we've had in writing proposals for NSF, you're dealing with different cultures. We care about preservice and inservice teachers. That's the education culture. Our department cares about physics. That's the physics culture. It is very difficult when you're trying to keep these many things going at the same time to fit into all of those -- into all of those groups. And so at this point, I would like to be a little bit more specific and say for more than 30 years, our group has been conducting courses for preservice K-12 teachers, intensive NSF summary institutes for inservice teachers.

And by that I mean six weeks all day, every day. The national to national program that has local as well, and it is -- it's learning the material in great depth. So I don't quite agree that we can learn from the common things in all the disciplines, but you can learn reasoning when you have something to reason about, and you place very great emphasis upon the reason.

I also want to say during the academic year, we have what we call a continuation course once a week every Thursday for two hours. People who have participated in our program at any time are welcome to come back for credit. And what we have

is K-12 teachers, about 50 of them every week, coming back. Some of them took the course -- the institute eight years ago. Some took it last summer. And K-12, the teachers interact with one another and help one another. And it's really very, very nice, and you can see a elementary school teacher helping a high school teacher with a particular kind of material. These people have shared a common experience.

And so when I started this, I thought, "Oh, they can learn more. Oh, we can help them in the classroom." Yes, that's true. But what I didn't know is that they form a community, and that there's no place else that the community will be formed. What happened in Seattle and I think happens all over, administrators come and they go. Policies change, but we're there, and they know we're there. And they come actually for two hours, officially. They come before. They bring dinner. But that makes it a nice occasion. So that's what we've actually done as far as working with teachers.

But we have also used this opportunity to develop a laboratory-based curriculum called Physics by Inquiry. And it is published nationally, and it's primarily for the preparation but not exclusively for the preparation of teacher. The way we do it is we actually do the research. What is it that's giving people difficulty? What can you do? How do you know it works? And then if it works for us, will it work somewhere else? Because it's very hard to develop curriculum for people who are 3,000 miles away. And so what we do is we have people we know in various places, and they try and we get feedback.

We also do this -- and most of our time during the academic year -- with undergraduates. Undergraduates, their first and second year. More has been done to modify the way physics is taught than has been done, I believe, in any of the other sciences. And one of the reasons is because a lot of -- quite a number of people have gotten involved in research on the learning and teaching of physics, and finding out what students actually understand and trying to address instruction in that way.

And so we've produced something called tutorials in introductory physics. About 80,000 copies are out. Again, without NSF, none of this would have been possible. And what we do -- I think I've already mentioned this. We not only do this for ourselves, but we publish our findings so other people who develop these curriculums can use it as well. And as a matter of fact, physics has -- there is one. The textbooks for whatever you can say are better now than they used to be. They have changed quite a bit.

I will say as I said before, none of these accomplishments would have been possible without the support of the National Science Foundation. However, it's not easy. Unlike traditional areas in physics in which you are, let's say, productive, you're doing good work. It is assumed -- provided you are doing something that people believe is important, it is assumed that you will probably get funded. The attitude in EHR is sort of underneath it all is, "Okay. Let's give somebody else a shot at it. So only in education, it seems to me, you have to not have experience in order to do something.

And to some extent, the same holes I think when it comes -- sorry -- the same thing now, all the people who are getting regular traditional grants to do research in the physics division, chemistry division, et cetera, they're told they're supposed to put something aside for education, have that in the proposal. Who checks the merits of those proposals at that level? It's extra. And instead of coordinating things, they'll say, "Okay. There's something good going on, why don't you have a part of your grant involved in some project that we know works." Everybody gets his own bright idea. And in education, my colleagues who just would love to have a crack to one quarter at some course that they think they have a bright idea and know how to teach. But they don't suggest that's the same critical judgment that their own work is subjected to.

So I think that what you really need is to have at least some people in all the disciplines engaged in that discipline in the teaching and learning of that discipline in meeting the standards that we set for those we set in science. And the way -- I

can't tell you how it can be done except I know that the way in which it was done made a difference for me, was the opportunity to go, to get an idea, to write a proposal, and to -- and to have it funded. And what's happened is we have a group in the physics department now. I've got my tenure and promotion. My two colleagues have gotten their tenure and promotion that way. We have post docs. We have visiting faculty. And we just managed to support one another.

And the department -- actually, we get along very well with the department. It sort of in some sense tolerates us, but they tolerate us in a nice way. But it wasn't always with us. And if we didn't meet their standards, we would not be where we are. So I guess that's probably pretty much the case. I want to make another comment though. I think the business of separating preservice and inservice education is not wise. It will be a long time before we produce enough teachers, no matter how many revolutions we make -- evolutions or whatever we make in undergraduate education. I really think you cannot let the insert professional development teachers go while you do that. And I'm not sure also that mass programs, as some of the ones we have had in the recent years, are the way to go. But I don't think you should separate them out.

So I think that's pretty much -- oh, one other comment. Our research has shown -- this is relevant. Our research has shown -- no, it's relevant. Our research has shown that physics majors -- now, I'm talking about physics, but I'm sure it's the same chemistry. Physics majors do not understand the subject matter in the way they need to understand it to teach students K-12. We have the data that shows that. Neither may I say do most returning engineers and scientists. They understand at an operational level. They can use it in their work, but they have not reflected on the material in a way that makes them suitable to go into the classroom and to teach.

I realize it's a popular idea. I think that it's well meant, but they -- and they can't do it just because they don't know pedagogy. They don't know the material in a way that they can transform it for the students to learn it. So we have the

data.

DR. BEERING: Thank you very much. You remind me of an experience I had in Zurich, Switzerland when I served on the visiting committee for ETH. And there in the president's office was a gallery of portraits of luminaries who had attended that splendid university, and one of them was Albert Einstein. And I said, "Gosh, I remember that he failed out of here because he didn't follow the rules and regulations. He was always sitting with a pad doodling, having bright ideas." The president told me, "Yes, he failed. But after he got the Nobel Prize, we forgave him." So what whatever happens in that physics department, go for the Nobel Prize, and follow the bright idea. Any questions or reactions from our group?

DR. HOFFMAN: I appreciate your skepticism about sort of returning scientists and engineers, but do you believe that someone has the real passion and is willing to put the time in that -- we ought to be able to accommodate them?

DR. McDERMOTT: Sure. It's been our experience that those who have come, we have had them in our classes, are not willing to put the time in. If they are, of course. And I want to also say something I didn't say. I think it's really important for teachers to motivate students, to be inspiring. No question. But I want more than that. And I think the returning engineers and scientists who visit the class, the motivation is wonderful. But as far as building something, you really have to put in the time to get yourself to the stage where you can do it. They're more than welcome if they're willing to do that, but most of the ones that we have encountered have felt they have something to offer now, and why should they be a teacher the next day, because they know more than the people teaching their kids.

DR. HOFFMAN: Is there some way that -- I mean, I think most of our preservice education programs are designed for the novice teacher or the -- for the new person who's just gotten a degree in science or mathematics and needs to learn how to teach. I wonder if given the huge cadre of scientists and engineers who are going to be retiring in droves over the next 10 to 15 years, I

wonder if it might be worth thinking about ways to design a new curriculum that takes advantage -- that takes advantage of their expertise, but also respects the fact that they're not 22 years old.

DR. McDERMOTT: That depends how you teach teachers. When I made the statement about preservice and inservice teachers, they're the same intellectual group. You don't treat them in exactly the same way. The incidents of teachers, we had some of them spend 15, 20, 25 years in the classroom. But when it comes to understanding material in the right way, in the way that's appropriate for teaching what they're going to do, I have not -- we have not found that they are that different. And the returning engineer -- returning science and engineers, sure, if they were willing -- if they are willing to go through the same intellectual experience as inservice teachers do, I would see no -- then that would be fine.

DR. HOFFMAN: I'm just wondering if perhaps we need to approach the way we motivate them and the way we teach them a little bit differently because most of them have had very responsible jobs, and --

DR. THIER: May I comment?

DR. HOFFMAN: Please.

DR. THIER: As a young man thinking of what I will do at middle age, I think this question is very important, because it gets right at the question of differential staffing in public schools. These people have contribution to make, but I don't think it's critical, initial contribution. I think we should find ways to use them effectively as part of a recommitment to the only real renewable resource we have, our children and grandchildren. And I think it's extremely important that we don't try to find, as Dr. Elizabeth said -- as Elizabeth said, we don't try to find cheap answers. Our children are worth more. And people who are retired have other needs, other limitations. And I don't think I would like to see science and mathematics taught primarily by retired individuals, even though I am.

DR. HOFFMAN: On the other hand, many retired people are looking for -- they haven't retired because they're tired or because they're sick or -- they retire because they don't -- they want to do something different.

DR. THIER: Just think how we could use them in a highly quality way if we had differential staffing in the schools.

DR. HOFFMAN: I couldn't agree more. Thank you.

DR. BEERING: I think we'll adjourn this panel and have a five-minute break, and then we'll do the last six presenters together to complete the afternoon. Thank you very much indeed. Small break.

(Brief recess.)

DR. BEERING: We're ready to go again. We're so pleased to have you. Did you have any special order in mind in which you would like to speak?

DR. GENTILE: There are so many good comments and interesting perspectives, and three different people at least have given the comments that I would probably give. But maybe hearing them again is worthwhile because it says that we're coming to the same thing for different reasons.

I want to first thank you for holding these hearings and for inviting me to share my thoughts with you. And I come to you today as a research scientist, as an educator, and a president of the Research Corporation. Research Corporation is the nation's second oldest foundation, and a foundation with nearly a century of continued funding in scientific research and scientific education. Sandra Bush was on our board early in the years, and it soon led to the development and foundation of the National Science Foundation. So I consider maybe that maybe I'm a moss bringer (phonetic) in some way.

We accomplish all things with the Research Corporation, with the small grants to individuals of all types based on ingenuity. We give our grants to all levels of institutions. We found

that innovation outcomes are independent of size of award and size of institutions. It is the passion of the grade of individual and the grade of scientists and the intentionality of affirmation by the institution for the mission of the proposal that matters the most. This is the most important thing particularly for educational initiatives that institutions consider research in basic science and research in educational initiatives as co-equal partner issues in the mission that they have.

I'm going to talk primarily about the reports because they fascinate me as they accumulate on my shelves. And I keep looking at them, and I keep saying I'm going to read these some day. And as I do read them, they start to tell me a story. At least one report I read did have some very long lasting effects. It galvanized many people into understanding a problem actually existed. The issue is how responses to such calls to arms however are promulgated. Herein lies the problem. I think unlike many other fields such as medicine and law or silicon technologies, there is a loosely formed, uncoordinated and some might say that suspect body of research and knowledge that underlies education.

But because the educational enterprise is not bound together by this common thread or body of knowledge, there are many starting points for making decisions about the kinds of actions to take. And because there is really no national vision or coherent set of national policies about the roles and purposes of science education, the decision-makers are much freer to start wherever they please, and move in any direction that they would like and contribute little or nothing else to building the vast knowledge base. The overall result looks like grounding motion (phonetic).

Imagine what would happen if a similar set of policies and practices were in place for fields such as emerging and infectious diseases. If we think of H5N1, the bird flu, we could write a plan of that risk. But the national and international organizations that need to be involved in fighting pandemics are pretty much in place. There are third policies and protocols in collecting and adding to the knowledge base now and in the

future. Everyone recognizes the kinds of steps that need to be taken should the virus mutate.

Our policies for dealing with this latest challenge are founded on a long history of research and basic scientific principals. So too should science education. Perhaps the issue here with the reports lies in four different realms: The structure of the federal government and its relationship to the states, American complacency, Congressional discretion (sic), and for an extended period of time, the reports came largely from within the science and technology community itself.

Many of those reports spoke well to the internal audience but were considered, and maybe justifiably so, by others to be the usual requests for more funding. More recently the ties were made to innovation, competitiveness, a black world economically, and I should say scientifically, outsourcing, security and other issues. The convergence of more recent reports coming from many different sectors of the unscientific technology is very important. However, the will to make the necessary responses has never emerged.

Congress strayed from its vision to double the NSF budget by manned missions to Mars as they were proposed and by other events around the world and other distractions that caused diversions in the funding springs. Even the Congressmen and senators who are solidly behind this increased funding in STEM field research and development cite the difficult budget situations at hand. Many from the same body would prefer to talk about tax cuts that do not see the value of investment that might pay off 20 to 25 years in the future. The public seems to assume all is okay because innovations will continue and require no new investments.

If we drop to the level of the states, one can find not only the most entrenched systems related to a critical issue such as deeper preparation for licensure, but where wholesale exceptions are commonplace. Placing increased emphasis on and funding in the Department of Education for science and mathematics education has produced block grants to states, but little research and little

vision.

It has been another distraction, and it is mired in state bureaucracies. State level departments of education have not been a hallmark of innovation in most areas of the country and should not be expected to be leaders in better instruction and preparation in STEM fields. In most cases, they would still like a student to complete a degree in physics or chemistry or biology and an entire education curriculum to a tune of 155 or 160 hours in order to teach physics in high school with a BS degree, while at the same time allowing a host people to teach physics or chemistry on a provisional basis because we have a need. It's discouraging for folks who go through the longer process.

If we want to see continued interest in physics, chemistry, biology, and engineering, in particular we're going to need more attention to high school teachers of those in related subjects. They shouldn't have to decide between a career that pays barely enough to have a family or support a household in a house on what is -- as compared to what might be available should they go into another field. Currently, I see few incentives outside of passion and missionary zeal for individuals interested in middle school and high school teaching.

Another part of the answer might rest in our lack of understanding of fundamental institutionwise systemic change that is sustainable. With due respect to my colleagues at academic institutions where I are one, we are liberal bastion of conservative thoughts when it comes to making change particularly with respect to the curriculum. And here I am only mentioning the problems with any given single institution, led a lie across a coordinated effort for multiple institutions, led a lie across an entire state, and led alone across state boundaries for the entire nation. And yet we're asked to consider what might be required across the country, when we can hardly get across the departmental lines.

I would also like to mention any number of other distractions that we have to worry about from the Board of Education in Kansas to intelligent

design, to STEM cells, all of these are distracting what really needs to be done in science education. Now, I did mention that the reports are somewhat scattered and hard to fathom, but yet they all come to some common conclusion. So what I'm going to leave you with are recommendations for urgent action that have been pulled for 20 reports written over the last 36 months.

The first, a focus on students now in the pipeline. Support those students demonstrating promise for success in the study of science and math as they enter into and pursue undergraduate studies. And I want to underscore we have to get rid of the fraternity and sorority initiation phenomenon that occurs in year one science. Secondly give each undergraduate the opportunity for personalized experience with inquiry-based learning in classrooms and laboratories. Third, extend research opportunities beyond the classroom and campus, partnering. And last, in this category, capitalize on and celebrate the growing diversity of students in the American classroom. That all falls under focus on students.

The next category is focus on future workforce. And there's three recommendations there. The next, student learning in STEM fields to the world beyond the campus so students appreciate the relevance of their studies and consider careers that use the skills and understandings gained from study in these fields. My son was an environmental science major who became a law student who has now gone on to tax law and is going to work for a private concern dealing with environmental issues. Yet he's a negative stroke against his own institution because he can no longer get a Ph.D. And that's how the National Science Foundation tends to catalog excellence in what's happening.

Dr. Hoffman, if we were to catalog excellence in the way of looking at method of origin for teachers that are in our K-12 system and indicate that as a marker of excellence equal to at least the production of Ph.D.s, we might change the culture in our departments a bit.

We need to build regional collaboration, as has

been said before. And we're going to continue to say that again with (inaudible) organizations and businesses and small private foundations like the Research Corporation. And we need to respond to contemporary calls for interdisciplinary by nurturing and rewarding faculty who make the kind of cross-discipline connections they hope their students will make.

And I'm going to say one last thing then. Focus on innovation for the future. It's very important. Be a venturist on the venturist things. And I'm going to pull from the business higher education forum. Higher education must redesign itself. Education must be engaging, flexible, and interactive. Forward-thinking institutions that can lead the way must pioneer innovative, new efforts and become champions of redesigning and learning. Thank you.

DR. BEERING: Thank you very much indeed. Now we'll go to Maria Lopez-Freeman.

DR. LOPEZ-FREEMAN: I have been involved with the NSF probably since 7th grade. I was one of the NSF scholars in the first science reform. I did undergraduate research every summer because of NSF grants that came to the faculty where I was studying chemistry. Eventually when I came into teaching, I went into NSF funded progressional development programs. So I continue to think of the NSF as one of my intellectual mentors. And I thank you because I never know who to thank for all those wonderful opportunities that were intended or unintended that I participated in.

I am the executive director of the California Science Project, one of the subject matter projects in the University of California, Office of the President. We are an interested mental infrastructure for professional development of science teachers K-12. I also serve as the associate director of professional development for the new systemwide science and math initiative, and that's for the preparation of math and science teachers. This is a systemwide preservice program that is in the College of Arts and Sciences, and is to produce teachers of science and mathematics hopefully within four and a half years.

I appreciate the call that you made to us to try to help you think of very challenging and interesting questions that are part of my life, because my life is professional development, and my passion is science. There are many instances where recommendations, alarms, and statements from experts have not been heeded. Whether it's evacuating because a hurricane, immunizing our children, or switching to the metric system, there is a long history of disregarding expert opinions on different pronouncements.

There are also many instances where recommendations, alarms, and statements from experts have been heeded. However, the responses to the calls for rethinking science and math education has not always enjoyed high visibility, has occurred in main hostile environment, and has not always had the time to demonstrate effectiveness, but there have been footprints. And in the late 1980s, the California State Legislature authorized the University of California for the professional development of science teachers across the state.

At that time in California, curriculum frameworks and new assessment systems were in development for various content areas, including science. The successful implementation of the frameworks and assessment system depended on teachers with knowledge of science, instruction that focused on experiential learning and multiple ways and forms of assessing student learning. In response to this need, and as a response to the mandate, the UC Office of the President began to look around for the UC programs, educational research, and, yes, effective NSF programs and models that develop and grounded this infrastructure.

Currently, there are 18 sites of the Science Project located on campus. UC, SCU or an independent college overseen by leadership teams comprised by expert teacher, faculty from the College of Arts and Sciences, and the departments of education. Such teams provide extemporise and flexibility so that programmatic work responds to local needs and demand.

The early work of the Science Project focused on building and developing teacher expertise in

science and elementary schools. At the time, schools provided materials, resources, and time for the teaching of science. Currently, that is not case. Given the current educational policies and accountability systems, many schools have readjusted instructional days to accommodate only reading and mathematics. At best, 40 minutes a week are shared between science and social studies instruction.

In spite of these adverse impacts, the project continues its work focused on specific grades and disciplines. Our work builds on the structures and residues of either current or previously funded projects and programs in the state. NSF efforts have left a deep enough footprint so that those teachers and districts that participate continue to implement many of the inquiry practices and use those instructional materials that were sustained through programs, developed through programs funded.

However, lacking further support and resources to sustain and scale up these programs, the likelihood of continued implementation of such programs is not very optimistic. The scalability and sustainability are critical. The NSF needs to look to innovative ways to support projects that can work with and reach a greater number of teachers as well as help projects develop business plans that can sustain them beyond the life of the subject project.

There is another project that is beginning in the university, and it's a direct response to the mandate of rising -- what is it -- "Rising Above the Gathering Storm," and also in response to the Glen Commission in which I also had the privilege of serving. We this year at the University of California have started the science math initiative. It is an initiative that is starting with freshmen who have declared themselves as majors in mathematics and science, and they're being recruited into participating in the California Teacher Project.

We are supporting them by providing for them experiences in classrooms that are to some degree sustained with some of the internal resources at the university. It is our hope that within four

years, we will have cohorts of students that come through as majors in science and mathematics, and have an authentic choice whether to pursue advanced degrees in science, or to continue in teaching or go into intern and education programs. It's a pilot at best. We are starting this year. We are learning all about working with the faculty, academic faculties that are taking lead are there learning from us. And we hope to reach a maximum capacity in the year 2010 of 1,000 teachers out of the UC system.

You have a challenge right now, however, and the challenge of the national context is one of low literacy students. What do I mean by low literacy students? They are those students whose primary language is one other than English. They are those students who do not speak standard English or those students that, due to social class status, their own discourse patterns are different than what is needed in the classrooms.

While new and developing quality science programs are focused on reteaching -- rethinking the teaching and learning of science, the new emerging national context demands that the issues of academic literacy, English learners, and students in poverty to be taken as a very critical component of the national context and the core focus of students that will benefit from a quality managed program.

It is not enough to state that all the national documents are about science for all, and that programs and projects based on these documents are inclusive and enabling of student learning. Knowledge of what is difficult to teach in science and what is difficult for students to learn has ground and is ever increasing. As a result of research in the teaching and learning of science. A great deal of this knowledge has come from NSF programs seeking solutions to critical problems.

Now is the time for a new and more complex thinking about the science classroom. The roll and nature of communication between teachers and students is critical if there is ever going to be an understanding of what students know and understand. One of the challenges of the science classroom is a complexity of communication between

teachers and students.

There is another problem that I think we need to take issue with. What is science as an applied social contract with a larger society? Support for science and technology derive from two sorts of belief. First, that the intellectual endeavors contributes to material well-being of society, and secondly that science has an intrinsic value in terms of rational, empirical search after truth for its own sake. 60 years at NSF's founding, both of these beliefs were in a sentence. In 1958, the University of Michigan study showed that only 3 percent of the sample asked disagreed with the statement: Science is making our lives healthier, easier, and more comfortable. Only 6 percent disagreed with the statement: One of the best things about science is that it is the main reason for our rapid progress.

Today, large segments of the population are calling those beliefs into question. Whether it is intrusive technology or research thought to be a desirable or visceral reaction to a knowledge elite or a perceived battle between beliefs supported by reason and beliefs founded on faith. There is no doubt that the public perception of science is far different today and less benign than it was in 1950.

To be sure the world goes on while the contract is negotiated, perceived problems in our STEM education system cannot be resolved without also attending to this larger societal issue. Thank you.

DR. BEERING: Thank you indeed.

DR. BARTELS: I think I have five minutes, but I may speak quickly. So hopefully you can keep up.

DR. BEERING: Go to the core.

DR. BARTELS: I want to thank you for this important opportunity. This is a terrific time to examine these questions. As you're well aware, there's some great reports and testimony that have come in in the last 36 months as Jim indicated, and there's wonderful recommendations in there. Nonetheless, I do think that his recommendations

aren't just right yet, and that's the reason for this commission.

So what do I need? Me fear for this enterprise, this undertaking is twofold. The first is we're going to go back all the way back to the 1950s and pull out the old solution from NDEA and fail to take advantage of the accumulated knowledge of the NSF for the last 50 years we've been working. My second one is the fact that we'll forget to put a cost-effective misrubic (phonetic) on our solutions. So let me give you a perfect example of both.

A lot of cost-effectiveness studies have shown that, in fact, the impact of loan forgiveness in the scholarship programs for teachers and scientists have a marginal impact against the dollars that are spent. The differential is hard to determine as far as how many of these students wouldn't have gone onto these careers if they hadn't received the money. A lot of them are. And we've seen some studies from some prominent institutions to show that the delta may be as low as 50 percent or even as low as 20 percent. And there's one particular program that I know about that actually reaches down to the middle school grade shows that for every new scientist who showed up at an undergraduate level and taking this course has cost that institution about $120,000 per extra student.

So I want to suggest to you that, in fact, things -- there are a lot of other examples I cite in my written testimony, but in fact unless you look at the impact for the dollars spent, you could be misguided and heading down some of the wrong pathways. So let me put this out there, which may be a bit of heresy. But if our exclusive focus is on producing more scientists and engineers at the highest levels, that the positive impact may in fact be immediate but short-lived. If our goals are to avoid job loss to other countries and produce the largest number with Ph.D.s, I fear we're entering into an impossible race.

So what's the alternative? How else can we do this problem? In my view, it is to train the greatest majority of our citizens to be technically competent. Those who want to be med

techs, hospital techs, biotech labs assistant, systems analysts, traders, and even entrepreneurs, that technical competency is the key for this country to job creation, not job loss, and to replace the jobs we are losing. These are positions that don't require terminal degrees. They're the trades. That every one of these trades actually requires that kind of high level technical competency, and voice them through the traditional pathways that middle class primarily are.

So I believe, in fact, that our most powerful asset may be the Head Start that we've had since 1961 when AAA had declared for the first time that our challenge is science for everyone. And I was surprised to learn that, in fact, this is 50-year-old -- almost a 50-year-old mission, and that AAA was in front. And that ever since, we actually have tried to educate every student in mathematics and science starting in elementary school.

Now, certainly our nation's path to universal science and math literacy is populated with well-intentioned missteps and misstated hypotheses. But we also have learned a great deal in the last five decades. And despite our rhetoric, we have some astounding success to point out. And so for instance, in a recent analysis conducted by Eric Reismann (sp) from the University of Texas in Austin, he examined NAEP data from 1990 to 2005 from several major urban areas. And what he found surprised him.

If you look at the mathematics performance of students by race compared with national NAEP averages by race, some cities like Austin, Charlotte and Boston consistently outperform the national averages for black and Hispanic students by large margins. Moreover, black and Hispanic students in some of these cities were measuring the performance of white students in other cities. And Hispanic students in Texas today are outscoring white students in Texas on the same test in 1990. His main point, demography is not destiny.

So what gives in Charlotte and Austin and Boston? He points out to several possibilities. First he

notes that actually each of these programs were committed to a higher level mathematics program, many of which in fact were funded and developed by the NSF. And that each of these places stayed with the new program for five or more years, and that in fact sustained and significant professional development for teachers followed the curriculum for each grade.

And, in fact, one thing we have learned, and it has been verified empirically, that the closer the teacher staff development is to the actual student taught curriculum with respect to what the students are learning, the teacher is learning as well, it had the most direct impact next to student learning games.

Interestingly, not all of these cities received direct support from the NSF. However, my own hypothesis is that if you did an anthropological survey of each of these cities, you would find any number of artifacts and tools, curricula, teacher programs, development tools that were developed elsewhere without NSF support.

So my recommendation is that the commission must reach deeply into K-12 classrooms and change the fundamental experience that teachers and kids have in their everyday classrooms, or else why should we expect that any more than 20 percent of our students persist in these courses through their senior year in high school and a smaller fraction than that pursuing these degrees at the undergraduate level.

Think about it. Our country traditionally produces the best basketball players in the world. Italy and Brazil, best soccer players. Finland, interestingly, has a disproportion amount of the world's top class musicians. And in every case, these nations encourage all children to play at the youngest age, even if they're not expected to be world class performers as adults. But what they have done is developed the deepest and widest talent pool, which in fact becomes the basis of the pinnacle of excellence that the nations do achieve in those fields.

And that's the key to excellence and why we must invest in the long run in the earliest grades and

not necessarily worry about the number of scientists and engineers for the moment. Because if we worry about the total population, the scientist and engineer problem will solve itself with time. Plus, we'll have so much more in terms of the technical literacy across all job categories.

So if I was going to apply this cost-effectiveness criterion, then what would my rendition be? The first one, seriously invest, as NSF has begun to do, in the emerging cognitive revolution of science, and in places that are designed to translate that knowledge into extraordinarily useful things such as curricular, technology schools, diagnostics, assessment, et cetera. For the first time in our history, we'll actually base some of our programs on real research on learning as opposed to prior practice or political process of the term standard.

Second, consistently stimulate experimentation to find better ways of learning through curriculum, instructional approaches, exhibits, media, digital technologies, novel teaching programs so that new innovations are constantly tested, improved, or abandoned. Third, this has come up several times, provide two-year intensive teacher induction program that compares favorably with the very best medical residency programs for every teacher in mathematics and science so that not only do they stay in the profession, but learn how to become competent, confident, and successful teachers.

Our medical residency programs aren't there to save doctors, keep them in the profession. Medical residency programs are there to finally finish the education of a doctor so they can't get out of their preservice program. Why don't we do the same for education? Fourth, bring an insane amount of attention, experimentation in resources for community and technical colleges as that for K-12 and traditional four-year colleges, especially since many of our teacher start their careers there, what is their first math and science experience in those classes, and because most of our teachers oppose start their collegiate careers in two-year institutions.

We have learned, in effect, developmental

mathematics courses tend to be the second greatest barrier to technical completion, second only to Algebra I in high school. What gives there? When is the last time we looked at our developmental math courses. And, finally, close to my heart, we need to continue to charge and support the informal sector with zeal, media, after schools, which in a lot of ways NSF deserves almost sole credit for developing the capacity of that field through its ISC programs to continue to motivate children and adults of all ages to engage in the everyday question of science, mathematics, engineering, and technology. Thank you for your attention.

DR. BEERING: Thank you very much. Dr. Semper.

DR. SEMPER: Thank you for this opportunity to testify. And I think you'll hear some resonance as to what you've heard on the panel. I'm the executive associate director of the Exploratorium in San Francisco. And it's been my privilege to lead a number of NSF funded projects and exhibits, media in professional development. I'm also the principal investigator for the Center for Informal Learning and Schools, which is an NSF funded center for learning and teaching. You'll hear more about that later.

But maybe as importantly, I'm also a product of the '50s and '60s educational reform efforts both in and out of school, and Mr. Wizard was my friend indeed. Probably what's also not known as well is that the Exploratorium is actually a product of '50s and '60s education endeavors as well. When Frank Oppenheimer started it in 1969, he built (inaudible) in elementary education and in the laboratory reform at the University of Colorado in undergraduate physics laboratories.

Today the Exploratorium is a hybrid, a museum and a research lab, a place that really does investigations and research in learning both informal learning and also how to be an adjunctive K-12 resource. I want to make a commercial plug for the ISC world in general. This world has developed the world of museums and zoos, and other informal science and education enterprises has grown by leaps and bounds since the start of it in 1968 to become an important component of science

education today. The numbers have increased and, more importantly, the interest of these institutions in science education has increased.

The Center for Informal Learning and Schools just performed a survey of 2,500 of these institutions around the country and asked them about their work beyond the field or beyond the incidental program, what work are they doing to help support formal K-12 education. Over 75 percent of the institutions were doing advanced work in K-12 education. And these institutions have impact. They reached 62 percent of the schools in this country. And many of the students and teachers are affected by them on an annual basis. So that's the end of the commercial for the science -- informal science education world.

I want to comment on the three questions that we were asked and try to talk perhaps about them in a slightly different way. The Center for Informal Learning and Schools has been doing research on learning, the idea of learning in general, learning in informal settings, research and learning design, what it's like to design appropriate informal environments that support K-12 learning.

And probably as important to me in my mind, research and learning systems. What's it like to have systems at schools and systems at museums? And my comments are going to be based on really this last comment about really starting to look at the system and realizing that we don't really understand and certainly don't know how to negotiate to make use of our entire system. So when I think about the critical aspects in science education and math education that hasn't been talked about, I want to talk first about the notion of a distributed learning environment.

When we think of education, of course we think of schools. But if we change and think of education as being a kid's brain, following it around, you realize they live in an environment that's much broader than their K-12 experience. They go -- at home they have experiences. They go to museums and libraries. They go to after school organizations. They see media. They interact with their peers, with family members. They

effectively are moving in a distributed learning environment, each of which has an impact on their understanding about science and their learning about science and mathematics.

And if you step back and look at the system as a whole, what you see is a great potential in my mind where different components have a different role in the science education world. But you also see a incoherent system, a system that cannot come together in a coherent way. I would also point out that we also have a distributed science education improvement infrastructure modelled for many of these same institutions that are supporting the work of the schools to do good science education. Again, each has its own rule, and I would argue they were quite incoherent in the work they do.

So the first opportunity that I would hope that the commission might think about is the opportunity to actually see what we can do in a coherent way to bring together these components of the distributed learning environment. And I would argue that NSF is probably one of the only agencies to actually play this role because it actually funds in all of these domains. It funds K-12. It funds informal science education, media, after-school museums. It funds undergraduate work. It funds graduate work. It funds research. It is clearly the leader.

And here I'm going to make one side comment, because -- about undergraduates. And that is that it's beginning -- in my mind anyway, it's becoming increasingly clear that every school board member, every legislator, every teacher, every parent, every policy person, every superintendent has gone probably to an institute of higher education. What are we doing to affect their view about science and science education? Most of them are not going as majors. Most of them are going -- and we have a smattering of understanding of science. Can we reach them so that they actually have a better sense of science education in the roles that they will play in the lay roles that they play in the system.

No. 2, we were asked to actually think about whether a goal might be the development

promulgation set of principals, options, and strategies. I guess, I actually think that we actually have quiet a few of those. It might be interesting to recatalog them. But I would like to turn the question around and say I think the goal of the commission would really be to focus the role of the National Science Foundation to build a robust and improved infrastructure in science education.

NSF is ideally suited to support in basic research. It's ideally suited to develop the infrastructure necessary for improving this work. It has a peer review system. It can build centers of excellence. And I think my thinking is a bit impacted by the fact that we recently got involved in a project around nano scale science and engineering education with the formal science education community, the recent NSEE Project.

And I've been reading up there for the whole nano scale national initiative and realizing the power of that initiative is to develop a road map to, in this case, produce an underpinning, the foundations for doing research that will lead us into an entirely new industry in nano scale science and nano scale technology. It seems to me that we could actually do the same thing, and this mission could actually figure out the same set of principals and road maps that might work in science education.

Third, why are these recommendations that we've been hearing about and read about, and I was affected by, in fact, why are they not sticking? Why are they not being (inaudible). Well, here I've actually drawn on the work of Ryan Roland and some of the work in the reports of Mark St. John and others who point out that the improving infrastructure for science education and education in general is outside the system being improved. This is probably the only field where this is actually tolerated. In the world of medicine or civil engineering or all of industry, you always have the improving infrastructure inside the system you're trying to improve so you actually have staying power for the improvement, and the decisions that are made are actually rational and reasonable for the system.

We have a case where publishers are outside the system, the standards are created outside the system, the teacher development happens outside the system, assessment happens outside the system. And it's, therefore, a recipe for failure in many respects. And I would say looking at the recommendations, which are wonderful in this report in 1983, it's interesting to notice that they're 42 recommendations in there. Probably in my guess 20 percent have been implemented. Only 10 percent really affect the world of NSF. And most of the recommendations are in places where the responsibility and the authority don't align. So it's very difficult to actually -- there are wonderful recommendations, but it's no one's responsibility ultimately to carry them out, and there's no authority to say, "Please carry these out."

Finally, I would say in closing that I think the commission itself basically should have a charge to look mostly internally at NSF and look possibly at NSF and its relationships with federal agencies to develop a road map really for science education, math education in support for the development of this infrastructure, to then figure out the appropriate connections systemically with LEAs and SCAs and all of the other agencies. In other words, I think that's something NSF can do well.

And I'm confident, actually, that they can create and sustain the system, and then with partnerships figure out how to solve this problem of the fact that it's outside the system by linking it appropriately through the players who can do something about the things in the system, whether it's SCAs or the LEAs, or other people who actually have the power to make the changes that we hope to find. Thank you for your attention.

DR. BEERING: Thank you indeed. Very insightful. Reaction?

DR. VASQUEZ: Maria, on your program, your literacy program that you are developing, could you talk a little bit about that, please?

DR. LOPEZ-FREEMAN: Sure. Within the Science

Project, we realized early on that it was becoming very difficult for us to deal with some of the new state textbooks that were coming into the classroom and the literacy issues of which we had little knowledge. And so what we did was -- at Berkeley they had a reading program a professor there that I invited to come and work with our project, which is science community, to help us really decipher and get at the issues of language. What does it mean to really use the text appropriately?

And interestingly enough, we found that both teachers and students need to learn how to do this. So we've been developing protocols and tools so that as we go and work with teachers, as we go -- we have multiple partnerships across the state with schools and districts. We begin to attach literacy as an unintended outcome of science because what we have really been trying to do is argue that you can't read about nothing. You have to read about something. And so why not read about science.

And if you're going to be learning how to develop language, if you're going to use the context of discourse, developed discourse, you have to have something about which to talk about, about which to put forth opinions, about which to argue. And the most logical sense of program would be science, because it uses children's direct observation of the model. You don't have to interpret it as what one would have to do in history. The direct experience is there and (inaudible).

So we have been working very intensively probably for the last four years on this, literacy at large, about reading, and also about English language learners where we've done the same thing, taken experts from that field and brought them into our community and helped us with an intended outcome. We have some of the university faculty, some of those physics professors, some of the professors that are working in different projects now rethinking learning because it had to really deal with learning as an issue. In this case, the teachers (inaudible).

DR. VASQUEZ: So bringing those outsiders of our

community as we call them --

DR. LOPEZ-FREEMAN: Yes.

DR. VASQUEZ: -- into looking at --

DR. LOPEZ-FREEMAN: Right. At the very core, I think modernity is about complexity. And we actually problemitize (sic) the teaching of science to include literacy, the issues of language, the issues of communication, and building upon the fact that we don't know all that we need to know in order to deal with today's context.

DR. VASQUEZ: Right.

DR. HOFFMAN: I just wanted to thank those of you who reminded us of the wonderful post Sputnik program. I too was a Sputnik kid. And by a circuitous route that included getting a Ph.D. in history, I became an economist. And the education I got from 7th grade to 12th grade through the post Sputnik program was the -- one of the defining experiences of my life and probably is one of the reasons I'm sitting up here today. And I think that yes, we need to -- we need to do it in the context of everything we've learned over the last 45 years or 50 years, and we need to do it much more broadly. And that was really focused on the top 5 percent.

On the other hand, it made a huge impact on a generation of students who are science literate today, math literate today in ways that they never would have been had they not participated in that experience.

DR. GENTILE: A comment, follow-up to that. You can trace what's happening now back to that. But I think that's happening with infrastructure in science buildings across the United States. So many science weapons were built in that post Sputnik era because the resources became available, and they've all aged at the same rate. And now Arbitux and construction firms are getting overloaded with the number of science buildings that again have been going up.

Well, I think you can say the same about

education. And if the metaphor for the science buildings aging and being out of date and honestly unsafe, we might say the same thing is happening to the educational system in its time. And I'd also like to think of Friedman's book as the new Sputnik.

DR. HOFFMAN: I think Friedman's book is the new Sputnik. That and "Rising Above the Gathering Storm" together is the new Sputnik. And I have to tell you the National Science Board is embracing it, cheering it, and trying to do what we can to move along.

DR. BEERING: Any other comments? When I was working with students in the lab in the Clinic of Betsize (sp), I always tried to demonstrate I was a learning enthusiast rather than a teacher. And I was gratified by the fact that they came along and got excited about what we were doing. You mentioned that kind of thing.

DR. VASQUEZ: Several of you mentioned the curricular -- curriculum projects which have been developed through NSF funds over a course of history. And Dr. Thier also brought that up, and Elizabeth as well. Building on those experiences, do you think that that might be something that would be needed more of, or building upon what we already have, enhancing that? What's your comments? Okay. Dennis.

DR. BARTELS: Two points. There's this terrific article from Schofield and Burkhardt. If you take a look at the history of NSF funding in the area of mathematics education starting in the '70s and '80s, and what they noted was in fact a lot of wonderful basic cognitive research was done in the '70s and '80s where they discovered that this notion of which is more, six or eight, ten or one, you know, whatever it would be turns out to be one of those really critical transitional skills where five-year-olds, that if they get it, by the time they leave age five, even if they came in at age five, they get it by the time they leave, their trajectory is as high as somebody who knew that before they got to kindergarten. The kids who come out of that not knowing that fact, their trajectory in math, could go down very quickly.

That kind of cognitive research got incorporated curriculum and standards that came out of the '80s movement. And if you recall, the first math curriculum work coming out to '95, '96, '97, but in fact what you begin to see now, especially in a lot of the urban centers who have embraced a lot of the NSF curriculum with strong development and implementation plans and consistent leadership I think is partly to the credit of why we've seen some steady increases in the NAEP scores in the last 15 years. But their point is, wow, that took 25 to 30 years.

The magic of it is it was based on cognitive research that NSF was now putting a half a billion dollars into the science and learning centers. But that research can't be by itself. There's got to be sort of this next part in the pipeline that says, okay, take these great ideas, but what does that mean when you look at an assessment, at a technology tool, at a curriculum, all those things that real teachers and real kids use every day to try to understand complex science and mathematic. And so what I'm hoping is that the NSF doesn't abandon its traditional role to fund those people who take good, interesting insights from research and still have to turn to something really practical that works for an ordinary teacher or kid.

DR. GENTILE: Just a very quick comment. I think it's relevant. I come from a liberal arts background both in training and --

DR. VASQUEZ: We'll forgive you for that.

DR. GENTILE: And I have a philosophy and a theology minor on top of it all. Having that said, I've been a co-chair of the National Academy Summer Institutes in biology education for R1 institutions, and I just want to share something with you about the curriculum. When this was first initiated, we had about 30 converts. And we all got together and wondered is anybody ever going to come to this, and that was three years ago. And these are being run by Joe Handlesmith (sp), University of Wisconsin, and underwritten by both Research Corporation and Howard Hughes Medical Institute.

Second year, we had 18 applications or 18 slots of teams coming from R1 institution. Last year we had 30 applications for 18 slots of teams coming from R1 institutions. And this year I think we're over 60 applications from Research 1 institutions that are taking curriculum reform, in this case it's biological sciences, that demands an integration of chemistry, physics, math and biology all together.

So I have to applaud the Research 1 institutions for moving in that direction, and now I'm hearing the howl from the liberal arts and the PY sector in general, that they want in too. So I think the time is right for cross-disciplinary curricular reform in the colleges and universities. And that's really built on the strong basis of curriculum reform that the NSF has supported over the years.

DR. BEERING: Thank you very much. We'll adjourn this panel, and we have two more. And then we have several public comments. So I invite George Scalise and Andrew Viterbi to come forward.

Who wants to start?

DR. SCALISE: First of all, I'm going to dispense with what I think the problem is. I think we understand what the problem is by now. And I think the issue needs to be focused on what are we going to do about this. If you look at the studies that have been done, and we have enough studies now, I believe, whether it's the national academies or the President's Council of Advisors on Science and Technology, or the business round table, or on and on.

They all come to about the same conclusion. There seem to be three issues that need to be addressed today. And they're interrelated, they're interdependent. First and foremost is further additional funding of basic research in the physical sciences to match the needs of today's world. That's No. 1. The second one is to deal with work force. There are two components to that. One is dealing with the foreign born student, which is the foundation for our current strengths in our graduate schools in the physical sciences and other areas as well.

The second piece of that is what I believe this panel is most focused on, and that is the K-12, what are we going to do to get that really on track. And then the third piece is the investment climate. To make certain we have an investment climate that allows us to compete. And with that, we must then choose to compete. So those are the three issues that have all -- each of these studies come to that same conclusion.

One of the statistics, the only one that I will quote that alarms me the most is that one of those studies somewhere along the line indicated that they found that when it comes to technical literacy, the 46 to 55-year-old folks in this country are more technically literally than the 16 to 25s. Now, I find that so hard to understand and hard to believe, but nonetheless that's what they said.

And when you think about where we started out with virtually none of what is available today, where they have lived their whole life with what's available today, you would think that would be just the reverse. So I think there's a very subtle issue here that needs to be addressed. I think that when it comes to these three issues, the president's issue deals with one of the most important ones in very explicit terms. And I would just point to that one issue. And that is when it comes to the H1B cap in dealing with our foreign born students, they recommend exempting U.S. educated knowledge workers with advanced degrees for the H1B cap. I can't think of anything that would help the current situation more than dealing with that one item.

If we do that and we allow these young people to come from all over the world, we encourage them to come here, and then make it easy for them to stay here throughout their educational period, and then beyond that, to make it easy for them to stay here and live and work and contribute to this society, it will be the greatest contribution you can make. So as I look at what it is that we need to do now, if we take these three things, and in particular work for it, divide it into those two components, and deal with each of them individually, but in parallel, I think it's what needs to be done, and

maintain the vigor of the economy, the technology the environment has provided in the last 50 years. So I'll stop there and turn it over to Andy.

DR. VITERBI: First of all, being the last speaker of the last session, I'm reminded of President Sample's remarks this morning, and I will say that I'm very grateful to you all for staying through the whole thing.

DR. HOFFMAN: Look behind you.

DR. VITERBI: And then also President Sample, one of his many talents is as a author. And he's written the Contrarian's Guide to Leadership. And I take a page from his guide and will be somewhat contrary, and I thought it was going to be totally contrary, and George here stole some of my thunder.

Let me begin by saying I appreciate the opportunity to testify in front of this board. And I should start by talking about my qualifications or lack thereof to speak on the topic of critical importance to our nation. I've only limited experience in K-12 education. My own experience goes back over a half century. My children's, a quarter century. But I do have grandchildren who are there at the present time. And the four schools that are represented by three generations of my family span categories of the public sector, private, parochial private.

My wife and I care deeply for education at all these levels and for each of the three categories of K-12 institutions that I just mentioned, we've endowed respectively, a computer center, a science building, and a library. I taught electrical engineering, information science, and applied mathematics at the university upper division of graduate school levels for over three decades. So ten years full time at UCLA and subsequently for 20 years part time at UC San Diego, in which I'm now emeritus.

In two technology companies which I participated in founding, I recruited and mentored scores of engineers and scientists, both new graduates and experienced professionals. I'm going to summarize my impressions and beliefs formed over a 50-year

career, a 50-year career that started right when -- several of you mentioned Sputnik. I had just graduated from MIT and had started working at the jet propulsion laboratory, and I dare say Sputnik probably had a greater influence on me than most people, because within three months of starting, we were suddenly tasked with creating the first satellite that United States put into Explorer 1, and I worked on the telecommunications and telemetry systems. And from that experience, I actually followed pretty much everything I did thereafter.

Let me now make my four points, my four observations. The first is simply that our society has tragically shortchanged the great college teaching profession K-12. We've been talking about it today. It's poorly remunerated and underrespected. In fact, sadly enough in society, the latter follows. The reasons are many and much has been said about them. But the consequence is that all too often, highly qualified math and science teachers, if they reach that point, they're lured away by private corporations, thereby aggravating an already critical shortage.

I strongly support their recommendations in the Academy's "Rising Above the Gathering Storm" report, particularly in the first category. Therefore, the first category deals with K-12, relating to teacher training incentives and initiatives. Second, at the college and university levels, our nation is in better shape. Our best universities are regarded as role models for institutions throughout the world. So clearly there's a disconnect between the sorely degraded K-12 pipeline and the colleges and universities which it feeds.

And this will -- this is partly explained by my next point which is that the belief that the world is flat and that we live in a global village pertains not only to goods and services but to brains as well. The situation prior to 9/11, when visas for foreign students to come and learn at our universities were readily obtained, made entry to our institutions of higher education the goal of a large percentage of foreign students, particularly those from the Asian nations with

large populations.

Indeed, but for this influx, most of our science and engineering graduate programs would be unsustainable. And these include many of those top 60 research universities, which Provost Nikias highlighted this morning. The repair of the visa processing and visa extensions functions as also mentioned by the Academy's "Gathering Storm" report is critical to preserving our lead and attracting grants, especially as we begin to face serious competition for the best foreign students from several other English speaking countries that are now attracted.

This is not to say that we don't have brilliant home grown minds in our country. Just that we don't have enough youngsters either prepared or motivated -- and I would say motivated is the key term -- enough to take on the rigorous intellectual journey towards an engineering or science degree. And in today's advanced technology environment, a graduate degree is usually a prerequisite for innovation. The foreign student who often comes from an underprivileged family background will be far more motivated to succeed in obtaining that advanced degree, which opens the door to the American middle class prosperity.

Finally, my fourth point is that an even greater proportion in our universities, technology based industries, such as those in semi-conductors, telecommunications, software and biotech technology rely on foreign-born scientists and engineers. Without them innovation would be noticeably curtailed. We might ask fundamentally what attracts knowledge-based workers to our country. Certainly many come for the education and choose to remain for the research and development positions which are unavailable in their own countries.

But I think there is a more powerful force of attraction, which creates, in fact, the one bright spot in an otherwise dark horizon. No nation today matches our ability and willingness to offer opportunities to the capable foreigner who chooses to come to stay and contribute to our nation's capabilities, economy, and progress.

Consider, for example, in another field what other country would entrust its foreign policy to a foreign born secretary of state or a foreign born national security advisor? Yet, this has happened here in our country three times within one generation. Closer to our own concerns, science and technology, what nation has as many foreign born CEOs, company founders, leading engineers, and scientists, university professors of science and engineering and venture capitalists as we have in our technology centers.

In summary, any valid initiative to repair and improve precollege education should be pursued aggressively, for it will produce the greatest benefit for our society, as has been stated many times today. The recommendations in the "Gathering Storm" report provide a reasonable start, but any positive consequences from these will be years in the future. In the meantime, our best hope for maintaining our lead in technological innovation is through the encouragement of talented immigration, preferably through admission to institutions of higher learning leading to employment and positions requiring advanced science and engineering education, which would otherwise remain unfilled. Thank you.

DR. BEERING: Thank you very much, indeed. Any reactions?

DR. VASQUEZ: I have one question. One of the things that we talked about is how to compensate teachers. And we know that -- particularly high school teachers, math and science teachers. Do you think, in your opinion -- and I'm not asking about your particular companies and corporations. Do you think that industry may be receptive to having these as workers in the summer time or, say, a six-week period of time where they are working side by side with other researchers and as a colleague in that endeavor? And it's a question. I don't know the answer to that.

DR. VITERBI: I would say the answer is yes. I can't pinpoint it, and I don't want to speak specifically about companies I've been involved with, but, yes, I would say definitely there have

been initiatives along those lines. There is a reverse side to that question unfortunately. And that -- occasionally, these same people that come for the summer do an interesting software program. For example, then decide, well, maybe they'd really like to stay. And that happens not only at the high school level. It happens at the college level occasionally also. So there is a drawback.

But on the other hand, I think that any department of education that really wants to set up a program like that, it could be very useful, and it could provide the kind of summer additional remuneration that would make your their life a little better answer.

DR. BEERING: Yes.

DR. HOFFMAN: A follow-up on that, because I think another way to perhaps look at this is that -- perhaps we need a national well. And it probably needs to come from the business community to really push for the kinds of suggestions that have been made all day today, for 12 month contracts, for differential pay, for math and science teachers, for differential incentives, for required inservice preparation -- inservice education. And certainly, in part with the impact of "Rising Above the Gathering Storm," the bills that are going through Congress, introducing into the president's state of the union address, the emphasis on innovation and science.

It's no accident that the U.S. business community put a great deal of pressure on Congress and the administration to make that happen. And I wonder if that's another sort of step in what I believe and what I hear so many people saying today is an essential transformation that has to take place.

DR. SCALISE: Well, you know, again, I think you're right. And I would hope that the kind of thing that we're all working on and toward will help make that happen. We fund about 80 million dollars a year at the University of Research throughout the SIA. This is over and above what the individual companies do as well. And we're always doing everything we can to make certain

that these programs are funded well and that the researchers at the graduate level as well as the professors are being compensated in a way that incentivizes them to be a part of this whole program. And we have a way of doing that just by virtue of the kind of programs that we have.

I think if you look at it from a formal standpoint, how do you modify the compensation program, clearly, that's always a -- a big issue when you're trying to talk about the whole education system in the country. But there are lots of experts in that area as far as compensation, and it would seem to me that it's probably more of a -- and I'm not an expert in this area, but it's probably more of a local school district issue to deal with as opposed to trying to do it on a national basis.

The things that we looked at and the studies we've done -- I headed up the P-cast study for the president -- it was more on what is it you do from this global look at the world. And it turns out that everyone came to the same conclusion. We did our study two years ago, and everything else that has been done has been along the same lines. Now, some of the implementation is where you're looking, and I think there are a lot of ways to go about that. But I don't think we have one formula that's going to deal with it.

DR. VITERBI: I do believe that's correct. I do believe that a number of school districts in California have collaborated in the Bay Area in particular and also in San Diego. There's been an initiative to getting the industry involved in K-12 education.

DR. BEERING: Again, our profound thanks to both of you and all our panelists. I will ask Mike Crosby to introduce the three individuals who have asked to make public comments, and then I'll have brief closing remarks.

DR. CROSBY: All right. We have a public comment period. We have three individuals that have registered make some comments. And in the interest of equality, they will follow the same guideline, five minutes. Except this time instead of Clara standing up, I'm going to ask Bruce to

stand up and walk toward you. He may have a little more enforcement clout than Clara. But the first speaker that's registered is Myra Bassin. Are you here? Okay. One down. Peggy Dabel or Dabell.

MS. DABEL: Am I supposed to come up here?

DR. CROSBY: Yes, please. All right. And we have some materials also.

MS. DABEL: All right. Clara is passing out a little packet that gives an indication of what's in some of the boxes I'm going to talk about for the DLESE Teaching Box Project. My name is Peggy. I'm a middle school science teacher, one of those people. I'd like to address the rule of the national digital libraries and the impact they and their projects have or could have on our students and teachers. DLESE, the Digital Library for Earth System Education, is a library with which I'm most familiar. It's funded by NSF geosciences directorate.

From a teacher's perspective, there are two primary problems in science education today. First, teachers are often required to teach outside their area of expertise. Teaching in areas where they may have only a superficial knowledge of a particular science discipline. Second, our kids face huge distractions, deal with life issues well beyond their age and give little attention to their education and things academic. Picture for a moment a classroom of eighth graders coming in after lunch in a game of basketball. Young people more interested in what they're wearing than what's happening in the world. Try to imagine how to engage these 35 lively students in any academic endeavor, let alone science.

Our challenge is to capture their interest with high level science teaching. Life and career choices are often made in the middle school years. The students explore what most captures their interest. We have an opportunity to take an already captive audience. They really can't escape the school. Provide them with tools, feed them with information, and free them to explore the future. And what is science if it isn't exploration?

So how do we engage these 35 vibrant young students and the teacher who may not have the tools to teach the assigned discipline? The answer is to tap into the power of the digital world. And in particular, to tap into the national digital libraries and the projects associated with them. This generation of children is using computers with the same dexterity that we use paper and pencil, the difference being that paper and pencil have limitations, but the Internet and digital libraries are limitless.

Today's students see the world in three dimensions with morphing shapes and colors. They travel through the digital world with energy, confidence, and enthusiasm. They're fearless in searches for answers. Too often the civility is wasted on games and chatroom. We need to harness this passion for the virtual world and direct it towards materials and experiences that can satisfy their innate curiosity.

Kids see computers as fun, but they are in fact the single most viable tool for learning in the present and in the future. Technology captures their attention, feeds their creativity, and allows them to think that they're not working, but having fun. We also know that teachers vary in their depth of content knowledge. But even the most experienced and well-versed teacher needs access to new theories, information, and methods particularly in science where the information changes hourly.

The problem that has existed in the past with the use of digital libraries is that teachers, unlike children, are afraid of technology. We did not grow up on a diet of instant messages, I-pods, and CD-Roms. These are alien to many of us over 50. We need to assure that teachers who venture into the digital world find it to be a reasonable and comfortable digital process. The DLESE Teaching Box Project responds to these concerns. So you might ask, "What is a teaching box?"

Well, in the past teachers could access museum resources in boxes that were actually mailed to the classroom. They would include samples of textiles, film strips, audio tapes, and opening

the box was really a magical experience. With the contents of the boxes, the written word came alive. The secure (phonetic) in each box required significant effort, and the boxes were limited in size and scope. Today teachers find it difficult to gather all the materials to comprehensively teach advanced scientific concepts or even elementary ones. But in the virtual teaching boxes that were developed by teachers working with DLESE, all the materials are gathered, neatly and elegantly packaged, and all the teacher has to do is let the genie out of the virtual box that has been created for them. And by the way, they work.

I'm a middle school teacher in a district struggling to provide a high quality education to a very diverse student population. Like many similar urban districts, our students test scores were well beyond No Child Left Behind goals. However, last year our school achieved a remarkable 67 point growth on our state academic performance index, which is used to document adequate yearly progress for the Federal No Child Left Behind Act.

Since the only new factor of the learning was the implementation of the DLESE Teaching Box Project in our classes, it seems apparent that this project with its emphasis on critical thinking and problem-solving had a major impact on student learning and across the curriculum. So I am asking that the National Science Board encourage outreach projects by the digital libraries similar to the DLESE Teaching Box Project and to provide funding and incentives that they would do so. Thanks very much for your time.

DR. CROSBY: Thank you very much.

DR. HOFFMAN: I would like to comment --

MS. DABEL: I wanted to say -- I'm sorry. I notice when you handed these out, this was like a little overview of a couple of pages from one of the boxes. Nobody put the code of the URL, so it's teachingboxes.com. And there are six. And they're full units and accessible and free, www.teachingboxes.com.

DR. HOFFMAN: I want to thank you so much for

introducing this to the audience as the chair of the Committee on Education and Human Resources. At our last meeting, we invite Kay Howe, who directs the Boulder project for the National Digital Library to come and speak with us. So we do fund this project. We are very interested in it, and we deeply appreciate your bringing it to the attention of the folks in the room.

MS. DABEL: Well, I just want you to know that this has been for me like the greatest thing since sliced bread, and I think I remember when there wasn't sliced bread.

DR. CROSBY: Thank you. Our next speaker is Dr. Joe Betser.

MR. BETSER: I'm Dr. Joe Betser with the aerospace corporation. And as a consumer of STEM graduates, I want to thank the Board and the participants for this important work. And my question has to do with culture and leadership. And when we observed the fastest growing economy of the largest country in the world, China, we observed that not one, not two, not three, but eight of their top politicians are engineers. And my question is why is it within over 200 years that our leadership that have there have been so few people who are STEM alums, if you would. So I would like for the Board to think about that because I think that drives a lot of the national agenda, and I thank you very much for your attention.

DR. CROSBY: Thank you very much. Last call, Myra Bassin.

MS. MORRISON: There were two of us, Eugene Bickers and Jean Morrison.

DR. CROSBY: I'm sorry. Neither one of you had been noted here. Jean Morrison.

MS. MORRISON: That's me.

DR. CROSBY: We don't have a note here that you wanted to speak. I'm sorry.

MS. MORRISON: Well, I'm here, and I do.

DR. CROSBY: Speak away. You're more than

welcome.

MS. MORRISON: I'm Jean Morrison. I'm a Professor of Earth Sciences at USC. I'm also the associate vice provost for graduate programs. Finally, I'm the director of the USC women's science and engineering program, and I'd like to focus my brief remarks on women in science and engineering here today. In addition, I'm the mother of two young children. I have a ten-year-old daughter and a seven-year-old son. So I'm also on the forefront of K-12 activities at home.

And my daughter who's extraordinarily interested in science is currently participating in Odyssey of the Mind, which is -- as you may know, it's an international educational program that provides creative problem-solving opportunities for students from kindergarten through college. And despite the fact that my daughter is in an excellent school with outstanding science curriculum, it is this Odyssey of the Mind program that is fuelling her really over-the-top excitement about science and the natural world. So it's interesting to me that this volunteer program led largely by parents and teachers at her school is really the driving force for extraordinary interest and motivation.

So I want to just briefly talk about the underrepresentation of women in science and engineering. And, again, a number of people have defined the problem. There are too few women in tenure tract positions in research universities in our country. And as our best and brightest young doctoral students look to the faculty to see how they can create a future as a scientist or an engineer, there aren't enough women on the faculty who are successfully combining having children with succeeding in a high-powered career that too many of these extraordinarily bright, ambitious young women choose to pursue alternative careers. So we have to work to change the characteristics of STEM programs because we're turning away too many talented people.

At USC we're very fortunate to have a unique program that is funded by a $20 million gift for endowment. The gift is for the sole purpose of increasing the women -- representation of women in

science and engineering. And we fund a broad array of programs from funding for high school students, undergraduate, grad students, and post-docs. But our primary focus is on tenured and tenured tract faculty.

And in the five years that the program has been in existence, we've doubled the number of women in the science and engineering faculty at USC. What we've learned from our experience, however, is that the people at the highest levels of the institution, including the school of deans, are our most ardent supporters and our full partners in these efforts, as are the students in the most junior faculty.

Where we find the difficulties are at the middle ranks within the departments. The department chairs and the senior faculty are where we have the most trouble making real advances. So as we look towards solutions for changing the culture, we have to find ways to bring department chairs and senior faculty into the program and recognize that there have to be opportunities for a variety of different individuals, including those who want to have children while they move through the career ranks. This has to be possible.

So then in conclusion, I think the two most important issues are that funding for NSF programs such as the advanced program, which works to change institutional culture, expanded and continued funding is essential. Those are extremely important programs for institutions where we're really working hard to make these changes. And also including in the assessment of faculty who have received funding for large research programs, assessment of the progress that they're making in building inclusive teams is very important. Thank you.

DR. CROSBY: Go ahead.

DR. HOFFMAN: I would like to invite you to go to our national science port web site and look for a report that came out, I believe, two years ago called "Broadening Participation." Are you aware of that?

MS. MORRISON: No.

DR. HOFFMAN: It has some very helpful hints on how to encourage your chairs and deans and senior faculty to develop strategies for broadening participation.

DR. CROSBY: Okay. I'm sorry. There was one other speaker, please.

MR. BICKERS: Yeah. Thanks for the opportunity to address the Board. My name is Eugene Bickers, and I'm a professor in the USC Department of Physics and Astronomy, and I'm also associate vice provost for undergraduate programs here at USC. I've taught physics to undergraduate scientists and engineers for the past 18 years, and I've seen many of my students go on to earn doctorates in their chosen fields.

I'd like to make one observation, which I think is important to keep in mind as we consider the future of U.S. Education in science, math, and technology. The most effective scientists and engineers are those who have both technical proficiency and an understanding of their disciplines context within the larger society. To achieve this balance of skills, our educational system must navigate into an increasing need for hyperspecialized training in technical fields and the advantages of intellectual breadth provided by a foundational liberal education.

The American university system has been uniquely successful in producing engineers and scientists with both technical proficiency and intellectual breadth. Because technical undergraduates in the U.S. spend considerable time honing their skills in the humanities, in social sciences, and in expository writing, they sometimes lack their Europe and Asian counterparts in advanced scientific skills at the end of four years.

It seems clear, however, that this temporary lack within the discipline is more than compensated by the benefits of a liberal undergraduate education in nurturing creativity and in providing a sense of societal context for later specialized work. To have maximum impact over the course a career, today scientists must be able to interact with other technical experts outside her immediate

field with commercialization experts and with members of the general public. The best venue for undergraduates to develop the necessary skill set is not a narrowly specialized technical institute, but a university which excels in both the sciences and the humanities.

An additional argument against earlier specialization in undergraduate education is the observation that the fields of technology which will change our lives most in the coming decades are intrinsically interdisciplinary. Genomics and proteomics, bioengineering, and nano science are fields in which mathematicians, chemists, physicists, biologists, and engineers must pool their skills in order to make significant progress.

Interdisciplinary collaboration succeed when each participant has a broad technical knowledge base which extends beyond his area of hyperspecialization. This art use for undergraduate training which has increased breadth within the sciences, as well as across traditional disciplinary lines with the humanity.

In summary, I would argue that in the 21st century, U.S. scientists and engineers must continue to receive the same broad-based undergraduate education that has distinguished the American system from its competitors in the past. If anything, we must increase the breadth of their training rather than tending toward early specialization. I thank you again for the opportunity to address the Board.

DR. BEERING: Thank you. Are there others?

DR. CROSBY: I believe that's it.

DR. BEERING: Let me then conclude our proceedings by thanking each of you for your thoughtful participation and commentary. And tell you my conclusion. Having reviewed all the reports that were discussed, having chaired the science, engineering indicator effort, which resulted just a few weeks ago in a two-volume publication, and having held three regional hearings now, I am indeed going to recommend to the National Science Board that we establish a new commission to

address the K-12 dilemmas that we have elaborated here.

It will be the purpose of such a commission in my mind No. 1 to fashion a national division about what is possible. No. 2, to elaborate practical reasonable and affordable solutions, and No. 3, to act as a catalyst for concerted action by the requisite agencies that are responsible, departments and organizations throughout their country. I have no illusions about our succeeding any better in 2006 than we did in 1983, but we must give it a try. It's worth the effort. There's now going to be a reception for all those of you who can stay. And, again, many thanks for coming.

(Whereupon the proceedings were adjourned at 4:28 p.m.)

DEPOSITION OFFICER'S CERTIFICATE

STATE OF CALIFORNIA)
) ss.
COUNTY OF VENTURA)

I, SERENA WONG, hereby certify:

I am a duly qualified Certified Shorthand Reporter in the State of California, holder of Certificate Number CSR 10250 issued by the Court Reporters Board of California and which is in full force and effect. (Bus. & Prof. S 8016.)

I am not financially interested in this action and am not a relative or employee of any attorney of the parties, or of any of the parties. (Civ. Proc. S (k)(1).)

I am authorized to administer oaths or affirmations pursuant to California Code of Civil Procedure, Section 2093(b), and prior to being examined, the deponent was first duly sworn by me. (Civ. Proc. S. 2025(r)(1).)

I am the deposition officer that stenographically recorded the testimony in the foregoing deposition, and the foregoing transcript is a true record of the testimony given. (Civ. Proc. S. 2025(r)(1).)

I have not and shall not offer or provide

any services or products to any party's attorney or third party who is financing all or part of the action without first offering same to all parties or their attorneys attending the deposition and making same available at the same time to all parties or their attorneys. (Civ. Proc. S 2025(k)(2).)

I shall not provide any service or product consisting of the deposition officer's notations or comments regarding the demeanor of any witness, attorney, or party present at the deposition to any party or any party's attorney or third party who is financing all or part of the action, nor shall I collect any personal identifying information about the witness as a service or product to be provided to any party or third party who is financing all or part of the action. (Civ. Proc. S 2025(k)(3).)

WITNESS my hand this day of_____2006.

SERENA WONG, RPR, CSR NO. 10250