DR. WASHINGTON: On behalf of the National Science Board, I would like to welcome all of you. I am Warren Washington, the Chair. This is the second of three hearings sponsored by the Board to consider the establishment of a new commission on 21st century education in science, mathematics, and technology.

Our first hearing was held in Washington, D.C. on Capitol Hill December 7, 2005. And we've scheduled a third hearing in Los Angeles on March 9th. The Board is sponsoring this activity because we are convinced that it this absolutely essential for the future of the nation that we address the weakness in our science, technology, engineering, and mathematics education system especially at the precollege level.

The National Science Board is an independent policy body established in 1950 by the National Science Foundation Act. The Board has 24 members appointed by the President and confirmed by the Senate, plus the NSF director who serves as an ex officio member of the Board.

The Board has dual responsibilities to, first, oversee and guide the activities and establish

policies for the National Science Foundation; and second, to serve as an independent national science policy body to provide advice to the President and Congress on policy issues related to science engineering research and education. It's under this second National Science Board responsibility that we have considered the establishment of a commission.

The Board is authorized to conduct studies and to establish commissions as tools to accomplish its statutory functions. A National Science Board commission is a rare undertaking for the Board and has been employed only at the rate of a single commission every ten years or so since the establishment of the National Science

Foundation.

The Board has a great deal -- has spent a great deal of time studying and developing recommendations toward improving student achievement in science and engineering, which is reflected in a number of reports coming from the Board including those included in the table of the background materials on the outside of this room.

You will note in our recently published

report to Congress Vision 20/20 for the National Science Foundation that one of our four major short-term goals for the NSF is to critically evaluate current educational investmerits and to develop new strategies to increase our impact on the quality of science, technology, engineering and mathematics.

We expect that your input today will help the Board in its statutory responsibility to guide the Foundation as it evaluates its current portfolio and implements new strategies to improve the qualities of the nation’s STEM education. Moreover, the Board feels strongly that the condition of the U.S. education systems demands the highest level of attention. It is, therefore, appropriate for us to study this question of establishing a commission.

The Board is grateful for the strong support it has received from members of Congress at our first hearing, and today we especially appreciate that Congressman Mark Udall from Colorado has agreed to join us and to take part in the discussions. I want to commend Senator Hank Brown, president of the University of Colorado system, for the wonderful hospitality of his

organization in terms of how it’s accommodated our needs to have the Board visit here for a few days.

I would like to stay a few words -- I would like him to say a few words. So, Hank, I wonder if you could say something to us.

DR. BROWN: Thank you, Mr. Chairman. In my previous occupation it was impossible to say a few words, but I will do my best this afternoon. Thank you for the privilege of sharing some thoughts with you.

This campus, as you know, is extraordinarily focused on and dedicated to outstanding science and engineering expertise, largely thanks to a member of your panel, Dr. Hoffman. Last year we graduated 1,405 engineering degrees last year alone. And you have already heard ad finitum both from me and from the chancellor of the positive parts of our involvement in science, but I hope it leaves you with the sense of our strong commitment in this area, our dedication to expanding it, and our commitment to expanding the realms of research.~

I wanted to focus on just a couple of quick thoughts that I hope might be worthy of your

consideration as you make recommendations. They would be these: One, I think the Alexander Dominici Bill (phonetic) has a great deal of merit to it and focuses the federal efforts in these areas in an outstanding way, and I hope is well worth considering.

Secondly, I'd like to share with you a thought that's personal. At the end of World War II, the Unites States, with roughly 6 percent of the world's, population, produced half the world's goods and services, phenomenal achievement. It did help, I suspect, that many of our rivals were utterly destroyed and unable to produce anything. But nevertheless it was an extraordinary share of the world's GNP.

Today with under 5 percent of the world's population, we still produce nearly a quarter of the world's goods and services somewhere in the neighborhood of 22 percent, an extraordinary achievement concerning the dramatic growth of productive services and science abroad. But the numbers are quite clear. Our share in the production of world's goods and services are declining dramatically as a percent of the world's GNP.

The other trend that is quite clear is

that we have some competitors. People have figured out our secrets. Free enterprise is no longer the domain of the American economy, but it is shared worldwide with people cpmpeting to adopt things that have made us successful. Secondly, our edge in science and research and education is quickly being diminished as other cultures and other countries understand our secrets and move forward with them.

In that regard, I wanted to share a personal story, if I might. Perhaps it will have some meaning to you like it has meaning to me. At the end of the Vietnam War, my wife and I adopted a Vietnamese family. They had a two-year-old little boy, Mm. Neither Nyut or Han spoke English. We had gotten him a job -- got Nyut a job. And after a few months, they -- I guess after six months, why they started a home of their own, but we stayed in close contact and have ever since.

In some ways, I feel like Mm is my son, obviously not genetically, but spiritually in some ways and we stay in contact. Mm grew up with two parents who didn't speak English and had straight A's in grade

I school, junior high, high school, went on to Colorado

College -- which I think, as many of you know, is a very excellent academic institution -- and had straight A's through Colorado College. And when he graduated from college we asked the family to come over, and we had a special graduation dinner for him.

And as we waited to go into dinner, Nyut, Mm and I were in the living room chatting. In the course of the conversation, I turned to Nyut and I said, You've got to be so proud of Mm and his record. And Nyut said, No. And I thought I'd misheard. I said, What? He said, No. I looked over at Mm who was sitting on the couch and he sat there with his head hung down in shame. And I said, What happened? He said, Mm meet girl, flunk out of school, disgrace family. Well, Mm hadn’t quite flunked out of school. He got a 3.5. He did meet a girl and got a 3.5 his final semester.

I thought about that environment and how thrilled I would have been if my son had gotten a 3.3 in Colorado College. And then I thought about the expectations that people have.

Each of us may have a different reaction to that kind of parent pressure. but there is no

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question that many countries in the world are hungry. And they want and believe they can have the prosperity that we have and they’re willing to compete for it. They have the, devotion and the intensity that Nyut and Han had for their son Mm. And they’re competing with our sons and daughters. And the only way we’re going to keep our edge, the only way, is to have the kind of intensity and devotion and competitive spirit they have.

In that regard, I want to share with you a couple of thoughts because I don’t think they’re widely shared, but they’re convictions of mine. One, the program in Colorado that requires high schools to prepare their students well -- they have four years of English, to have math and science and other requirements -- is absolutely essential.

And I believe it’s worthy of consideration on the national level to insist if you’re going to have federal funds go through K through 12 schools, that you also require the basics of curriculum that will prepare them for college to be able to compete. Not because you want to be mean to them, not because you want to overbear on them; but the simple fact is, without guidance, our

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high schools are not going to provide the kind of preparation that young people need to go to college.

The second thought I want to share with

you is on grade inflation. I know it’s a controversial subject. There are many fine people who I respect that say it doesn’t exist in this country. I think that’s nonsense. I don’t think you can look around this country and not come to the conclusion that we have dropped our standards, that grades are easier to get.

There are a few institutions in this country where we differentiate in our grading system between someone who does outstanding work and someone who does good work. There are few institutions in this country that flunk a student when they don’t fully comprehend the course.

At this own campus, we’ve seen the dramatic changes as you’ve seen in the finest institutions in the nation, and it goes to Harvard and Yale as well as to our community colleges. And we’re not going to be competitive worldwide unless our grading system means something. There is no longer the potential at pretending that everybody can pass and we can have a

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great system. Our grades have to mean something if we’re going to provide the proper incentives and recognition for students to excel.

, Lastly, I want to add my endorsement to ‘ the -- not only the Alexander Dominici Bill but to the funding that the federal government has brought forth in science and encourage its continuation. I think it’s an essential ingredient as we move forward. Lastly, I would encourage not only for our institution but other institutions around the world to seek partners in developing excellence in science.

Thanks to Dr. Hoffman and her predecessors, this campus has developed a number of public private partnerships with outstanding businesses in the Colorado area that provide inspiration and guidance and jobs and interaction with our students. And that contact with the private sector has been an enormous factor in stimulating students in the interest. I think that area is one that has great promise in the future.

Well, my hope is that I’ve stirred up some controversy. I don’t think we’re going to make progress,

r I don’t think we’re going to maintain our lead, I don’t think we’re going to be competitive unless we make dramatic and strong changes in the way we provide education in this country. In insisting on adequate curriculums in K through 12, in insisting that grading in a colleges and university mean something, and putting our money where our mouth is in terms of funding hard science, I think are all essential steps for America’s continued lead and advantage economically.

And otherwise, frankly, without it, I think we will face the same fate that other institutions in other states have where they haven’t been competitive moving on in the future.

Thank you for the privilege of sharing some thoughts, Mr. Chairman.

DR. WASHINGTON: Thank you very much. You certainly did have some provocative things to say, and that’s what we wanted to hear. I’ve asked Steve Beering to chair the Board’s activity on the STEM education commission.

Now, Dr. Beering is the past president of Purdue University and holds an MD from the University of Pittsburgh. He serves as the professor of medicine at

Indiana University and professor of pharmacology at Purdue. He’s been a member of the National Science Board since the year 2002 and is currently chairman of the subcommittee on science and engineering indicators that has prepared a 2006 report that will be released very soon.

I would like to turn over the activities of this hearing to Steve. Thank you, Steve.

DR. BEERING: Thank you very much indeed, Warren. It’s a privilege to be here. I see some friends in the audience and some alumni of the National Science Board, and I’m grateful to each one of you for making the effort to come with us today.

Now, let me begin by introducing the members of the National Science Board and caution you that not everyone can stay for the entire afternoon because of travel constraints. But the ones who are with us right now are Dr. Dan Arvizu; Dr. Ray Bowen; Dr. Daniel Hastings; Dr. Elizabeth Hoffman, the president ad mentor of this fine university; Dr. Douglas Randall; Dr. Daniel Simberloff; Dr. Kathryn Sullivan; Dr. Jo Anne

Vasquez; Dr. Michael Rossmann; Dr. John Strauss; and Dr. Alan Leshner. Did I get everybody?

And now I would like to make a special comment about the director of the National Science Foundation, Dr. Arden Bement, who holds a doctorate in metallurgical engineering from the University of Michigan, and most recently before assuming the National Science Foundation directorship was director of the National Institute of Science and Technology. He also serves as chairman of this Board’s executive committee, and we are most delighted that we have him in our mist as our leader of these important efforts.

Let me also mention that in May of this year, Dr. Washington will end his remarkable 12-year term on the National Science Board with the last four years serving as our chairman. He will then be able to focus more on his position as head of the Climate Change Research Section and the Climate and Global Dynamics Division at NCAR and his active participation in the many scientific societies of which he’s a member including the National Academy of Engineering, the American

r Meteorological Society, the American Association for the

Advancement of Science, the American Geophysical Society, and the American Philosophical Society.

The Board is pleased at the great interest that has been generated by our activities in regard to the proposed Board Commission on precollege education and science, mathematics, and technology. We are gratified by your attendance here today. We especially appreciate the support and encouragement of Dr. Brown and the University of Colorado, our hosts for this event.

Now, a few words about why the Board is considering a new commission on education. A commission on education falls primarily under our statutory responsibility in national science policy, although science policy recommendations by the Board will provide guidance to the National Science Foundation as well. If the Board establishes such a new commission, it will be the second NSB commission on education.

The first one was established in 1982 for the stated purpose to define a national agenda to improving mathematics and science education in this country. It was specifically charged to develop an action plan to include a definition of appropriate roles

for federal, state, and local governments, profession scientific societies, and the private sector in addressing this problem of national dimensions.

At the National Science Board meeting in March of last year, Dr. Warren Washington informed us of a number of requests from a range of organizations for the Board to reconstitute ‘82-’83 commission of precollege education in math, science, and technology. Most notable was the request from our Congress, which was posited during Dr. Washington’s testimony earlier in 2005, and the House Appropriation Subcommittee hearing on our ‘06 budget.

The charge for such a commission is yet to be determined by the Board, but we have received a number of different suggestions on the direction such an activity might take. Therefore in September of ‘05, we agreed to implement a process for considering a charge for such a new commission.

Let me mention that the’ ‘82-’83 commission~

study was coordinated with another commission under the Department of Education. That commission produced the report entitled A Nation at Risk, which effectively drew

attention to the weaknesses in the U.S. education 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 our elementary and secondary education systems in math, science and technology. The agenda was directed towards the nation’s achieving world class STEM education leadership by 1995 as measured by student achievement, participation levels, and other nonsubjective criteria.

As you think back over these years, 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 which are needed to sustain our preeminence in science and technology for the future.

In fact, the just completed next volume of science and engineering indicators, which I am pleased to note was just approved by the President and will be

i submitted to the Congress in a matter of days as well.

Our companion policy statement to indicators underscores the need for more effective K-12 system for STEM education. The data reported in the new indicators volume suggest that our American education in science,

technology, engineering, and math is not preparing our children commensurately with the future needs of a nation sole-dependent on excellence in science and technology.

By the way, we have a section of the indicators which specifically address the accomplishments of each of the 50 states of the union. When you read these stories, you will be dismayed, as I have been and my colleagues on the board, that we are no longer number one in anything in the world. The country that is eclipsing all of us is the small nation of 4 million people called Ireland. There are 40 million Irish-Americans in this country. You may have a relative over there.

In the Board's vision statement, Vision 20/20, for the National Science Foundation, which we also recently submitted to Congress, we identified the importance of a solid grounding and the fundamental concepts in science and technology for all Americans. We

emphasized the critical role of high-quality STEM education in grades K through 12 to ensure that every student graduates from high school able to participate fully inour increasingly technological world.

- We are pleased that others are drawing national attention to this national crisis, most recently the national academies with their new report, Rising Above The Gathering Storm, and the President in the State of the Union address last week. We are hopeful that this high level of national intention and the consensus which appears to arise from so many sectors of our society will mobilize us to take the necessary actions now to deal with this attractable problem.

. You're are invited here to participate in the development of a charge to a new NSB commission in education for the 21st Century that will focus on raising U.S. achievement in science, technology, engineering and mathematics to a world-class level. We look forward to hearing your thoughts.

I have reviewed and read each of the statements that our witnesses have prepared, and I am impressed by your collective wisdom and your enthusiasm

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and passion for this task. It is disheartening that so many outstanding ideas from the previous commission reports and the very eminent bodies have failed to result in the achievement of world-class performance to date.

Now, we are specially interested in how our new board commission could contribute toward implementation of effective solutions to the problems of U.S. STEM education. We are also eager to operate with the Department of Education which recently appointed a new commission of its own to address U.S. education and to work together with them toward our common objectives. It is widely and increasingly recognized that achieving excellence in a STEM education is crucial to our future national prosperity and security. We must not fail.

There are three burning questions that I would propose to our panelists and other speakers. First: Why have we not improved in the last 23 years? Second: Can another commission as contemplated really add value? And third: What incentives can we propose for students, their families, and our communities to get involved in this effort? We just must be successful as a nation.

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Before we begin hearing comments from our invited guests, I am going to ask the National Science Board’s executive officer, Dr. Michael Crosby, to my left, to explain how we are going to proceed for this hearing. Michael?

DR. CROSBY: Yes. Thank you, Dr. Beering. First, I need to make the usual announcement that we would like to have all cell phones and any other electronic noise-making devices turned off during the hearing. As your agenda shows, we will have five panel sessions. Board members will hold their questions until the appropriate point in the session indicated on your agenda as roundtable discussion.

We will request that speakers keep their formal remarks to no more than five minutes to allow time for discussion, and please speak into the microphones. We're going to help you keep time. I've asked Dr. Webber on my staff -- the largest member of my staff -- to stand at the four-minute mark. At the five-minute mark, he may start walking towards you.

We would thank you in advance for your assistance in keeping the schedule. We've set aside time

at the end of this hearing for those of you who have registered in advance to speak. I would remind everyone that this hearing is being broadcast live via the internet. We have a court reporter who is recording the entire hearing. And we would, of course, be pleased to have any additional written comments for the Board to consider from any of the speakers or any of the members of the audience. Thank you very much, Dr. Beering.

DR. BEERING: Thank you, Dr. Crosby. Let me mention that this is the second of three hearings that we have scheduled. And when we were in Washington a number of weeks ago, we were also privileged to begin the proceedings with members of the United States Congress. - Today we are delighted to have with us Senator Mark Udall to lead off the presentations and discussions.

Senator Udall?

CONGRESSMAN UDALL: Thank you, Doctor. I think you demoted me, but I don't want to get in trouble with my senate colleagues. I have a prepared a set of remarks. If I could, Mr. Chairman, ask that they be included in the record. And then I would like to make a few extemporaneous remarks. And then I'm looking forward

to hopefully a bit of conversation. I think we have 15 minutes or so.

I’m inclined to also want to acknowledge Dr. Bement and Dr. Washington and, of course, my great friend, President Hoffman -- and Dr. Hoffman. This is a very illustrious panel, and I have to confess I’m a certified layperson. Perhaps the only advanced degree I’m pursuing, Betsy, is one that’s a clinical degree, and that’s in some politics. And every two years, the review board is a group of voters that decide whether I’m worthy of another term of office. And I can tell you it’s not unanimous.

You all -- if you’ve been around politicians, you know we have stories like this. But I was in the market and a man said to me, Did anybody ever tell you you look like Mark Udall? And I said, Yeah. And he said, Well, it must make you kind of mad, doesn’t it? So it’s not 100 percent out there.

I’m here for a whole host of reasons, but starting off with the fact that in the 2nd Congressional District we have this magnificent blend of the high plains and high-tech institutions like the University of

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Colorado, NIST, NOAA, vibrant telecommunications and high-tech private sector, and they all help drive our economy. But they have, as I said, additional importance to us when it comes to national security and the future literally of our country and our children.

So the STEM disciplines are very important to me. I cochair the STEM Caucus with Congressman Ehlers who sits on the science committee with me. He’s an alum of JILA, knows Boulder well, and has paid us a number of visits. The good doctor talked about The Gathering Storm. I think it’s sobering. It ought to be reading for every politician and every teacher and business leader in the country. As I’ve mentioned, this is not just a matter of economic health, but it’s a matter of national security.

-So what are we going to do about it? Well I have two suggestions today for the Foundation. One is: We need to maximize the potential of our community and technical college system. They’re often overlooked, and I think this is an area where the NSF could have greater participation, particularly the ATE program. The i Advanced Technological Education program is a unique one enough. We had it at about $45 of the House to failed by just opportunity to interaction be

of the science proposals million.

increase two votes, go back and tween the NS The second community i

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geared for two-year institutions.

And Congress has been supportive, but not in this last Congress to fund I had an amendment on the floor that money to $70 million. It so I think there’s an

see if we can’t help this

F and community colleges grow.

area, I believe, is greater use

n the classroom. And there are two programs in the 2nd District I just wanted to highlight to the panel. One is the Rocky Mountain Middle School Math and Science Partnership. This is the only math and science partnership in Colorado, and it works with seven school districts and four institutes of higher education in the state, and it focuses on middle school.

The second program I want to mention to the panel is the Hands on Optics. And this links optics professionals with teachers at 18 different schools participating in the MESA program and the mathematics, engineering, and science achievement schools. It also has a real focus on minority and female students. So we

want to be looking to these two programs as an indication of some of the efforts that we could put forward.

Congress passed far-reaching NSF reauthorization legislation in the 107th Congress that included funding for science education in all levels. And I have to say I’m pleased that the bill includes some provisions that I’d introduced of my own legislation to provide scholarships to students or professionals who have a degree in science or engineering.

And in this Congress, Representative Gordon from Tennessee, who is the ranking member on the Science Committee, has introduced legislation ‘that would directly implement recommendations of The Gathering Storm report. And I looked forward to debate about how we can best serve innovation in the country.

So in sum, this is a real opportunity force, but it also is fraught with threats. And I want to commend the Foundation for holding these hearings and look forward to being an active participant and would welcome questions as a discussion at this point, Mr. Chairman, if that’s possible. Thank you very much.

i ‘ DR. BEERING: Thank you very much indeed.

You know university presidents are never wrong and seldom in doubt, so you’re challenged to go for the Senate next.

We're so very pleased that you're here. Are there comments or questions from the National Science Board - members for Congressman Udall?

DR. WASHINGTON: Congressman, I just wondered if you could give us some sense of the chances that some of this legislation is going to be passed.

CONGRESSMAN UDALL: I think the chances are increasing. The President's comments I welcomed at the State of the Union. My team, the democrats in the House, have introduced their own competitiveness initiatives. There's, I think, increasing understanding because of people like Tom Friedman, the National Science Foundation business leaders, President Hoffman, and her tenure here at the University -- that's reaching the congress.

I did have some notes I'd written on my prepared marks here to encourage all of you in the audience, encourage the National Science Foundation to meet with members of Congress to make the pitch. And above--all, when you have examples of successes, when you

have examples of opportunities, particularly in home districts and home states, those resident legislators are no different -- although we may seem to be so -- from the rest of the population in that we're moved by our emotions and our experiences and by what inspires us.

I think that's the opportunity to move this beyond statistics, beyond reports, to bring the right to the Congress. But I think we're poised for the renaissance, if you will, for reinvigoration, and for reinvestment in this very, very important area. The one caveat is that we have very difficult fiscal times facing us at the federal level, but there's no more important investment that we should make than in this area.

One other reference that I do think resonates with the legislators and lawmakers in Washington is the Homeland Security Commission, which is headed by Senator Redman and Senator Hart, that predicted the terrible events of 9/11 and then made a series of recommendations in how we respond.

After we were to set up a Department of Homeland Security in this report, they outline six key investments that this country has to make: a public

health system second to none; energy independence; the transformed military that's more focused on special forces than nation building; research and development investment that hasn't been unmatched in the history of the world; and, of course, the reinvigoration of K-12 and higher education.

Well, those are right up the alleys that we're talking about here today, and we ought to be putting that report in front of the members of the Congress because of the very powerful bipartisan group of individuals that served on that commission and who are seen as legitimate spokespeople for the directions in which the country should go in to enhance national security.

So this is, above all, concern and we ought to be very proud And we shouldn't be reluctant to point about national security and the future

DR. BEERING: Dr. Hoffman?

DR. HOFFMAN: Congressman Udall, first

all, I want to thank your committee and particularly Congressman Gordon for putting forward the bill on 10

a natural security to make the pitch. out that this is of this country.
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Thousand Teachers, 10 Million Minds. We just earlier

today, the National Science Board, approved a letter from the Board back to Congressman Gordon strongly supporting this bill offering some suggestions -- fairly minor, but we think important -- for changes, but basically really commending your committee for introducing this bill. We will be following it closely, and we are very excited about the bipartisan bicameral Congress and the President’s agreement on how important this issue is.

I’d like to ask the question which I asked each of the Congressional members at the hearing in Washington. As we move forward to develop this commission, there seems to be considerable disagreement as to whether this commission should focus primarily on the National Science Foundation’s education efforts or should look more broadly at the state of the science, technology, engineering and mathematics in this country.

President Brown issued an important challenge on curricula and grade inflation which seems to look to a broader mission for this commission. I’d just like to have your thoughts, as I got them from each of your colleagues who testified in Washington.

CONGRESSMAN UDALL: I appreciate the chance to comment. Without having drilled into these questions -- that’s my caveat to the response -- I think the broad agenda is one that’s worth pursuing if the commission has the resources to pursue it effectively, and if this group has the time and energy, which it’s always had in the past, to pursue it.

But I think we ought to be looking across the board to what the threats are and what the opportunities are. The Chinese with whom we are competing have a symbol for crisis, and that symbol is made up of two other symbols: one is danger and the other is opportunity. And I’d like to think that the opportunity here is where we ought to focus, but there truly is some danger if we don’t look broadly at both what ails us, but what we could do to help heal ourselves, and then be reinvigorated for the 21st century.

You put me on the spot, but I would support -- no, you didn’t -- but I would support the latter course, if the resources are in place, to pursue it in a way that the answers and the conclusions that are drawn are based on ways ranging interviews and testimony.

DR. BEERING: Other reactions from the Board? If not, thank you so very much, Congressman Udall. We look forward to your activities with Congressman Gordon as we go forward.

CONGRESSMAN UDALL: Doctor, thank you for including me here today. And stay tuned on the United States Senate. We'll see what happens.

DR. BEERING: Thank you. We are now going to constitute a panel of -- okay. There may be some defections because of travel difficulties I'm told. Keith King is here from the Colorado General Assembly House Education Committee. Susan Windels is here. John Evans, Randy DeHoff.

DR. DeHOFF: I'm here, sir.

DR. BEERING: Delighted to have you here. We would like to give you an opportunity to give your testimony, and then we'll ask the board to react and engage in a brief conversation with each of you. Who's ready to go?

DR. DeHOFF: Thank you. I'm Randy DeHoff, member of the Colorado State Board of 'Education, served

in that role for seven years. in aerospace, so I'm tended to science person on the state -board.

The question is that address -- one of the questions was years in all these reports they keep thing. Are we still asking the same gave some written testimony on this, expand on a couple of those points.

But first start by just quoting a couple of the recommendations from the 1983 report about educating Americans for the 21st Century. Those recommendations included adopting vigorous certification standards but not standards which create artificial bars to entry qualified individuals and to teaching strong math and science background for elementary teachers, full major and college math and science for secondary teachers, compensation for math and science teachers.

It’s appropriate to quoting their important role in academic excellence, their small numbers and their alternatives for employed -- recognizing the fact that you’re not going to get very

And background is. physics be the designated math and
we were asked to why after 20-some saying the same question? And I and I’d like to

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many math and science majors, even if they are interested in teaching who will opt for that career when they can make three times as much walking in the door in any of the aerospace companies here in the Front Range or even some of them up in the small mountain towns.

All secondary school students should be required to take at least three years math and science and technology, including one year of algebra and one semester of computer science. This requirement should be in place by September 1st, 1985.

Some of you may have seen just last week the Kentucky State Board of Education just adopted a requirement to require four years of math by the year 2012. One of the state board members remarked to that six and a half years. It only took us eight years to -put a man on the moon. And I suggested that is primarily points to what one of the problems are.

Any of us who have been in aerospace will admit that we never could have done that in the current regulatory environment. It just would not have worked. And we’ve got to take that same approach to education. So what do we do?

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We need to as the reports have recommended make it easier for mathematicians and science to get into teaching. And there have been some proposals this year in the budget along the lines of troops to teachers and

- Teachers For America of opportunities to get people from industry into the classroom.

I’d like to see industry step up to the plate on that and work out arrangements where some of their better qualified scientists and engineers can take a leave of absence for a few years, go into the classroom, get the training they need in classroom management and some of the pedagogy skills but not have to sacrifice the salary -- have the company make up the difference between a teaching salary and what they’re making.

A reverse method, look at bringing math and science teachers during summers or for a yearlong internship into industry so they can see what’s really going on.

One of the problems we’ve had particularly in secondary science is that too many -- in fact, a vast

i’ majority of secondary science teachers have never done

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science. They don’t do it in their science education courses. They’ve never -- they’re not science majors, so they haven’t done it in college. They’ve never worked in industry so they’ve never done it. So they teach it the way they-think it should be taught, and-kids are bored.

And we need to come up with ways to get more people involved. There was just an article yesterday of 10,869 students in teacher preparation courses in Colorado. 385 of those were in science, 287 were in math. Exactly five of those 10,869 students were physics majors. That’s one teacher for every 58 high schools in the state of Colorado. We need to do something to break that log jam open. Thank you.

DR. BEERING: Thank you very much Mr. King.

DR. KING: Thank you. Well, that doesn’t mean that since my other colleagues did, not show up, I get their time. Politicians always like that. Betsy, it’s good to see you again. And thank you for the opportunity to come here today.

I am going to talk about one of my favorites discussions I’ve had since I’ve been in the

general assembly for eight years, and that’s how we are having dramatic problems with K12 education in the service of boys. And as you know, math and science concepts tend to be more dominated if you would say buy the male gender, but I think we are having some dramatic problems in K12 education that need to be addressed specifically surrounding how we educate boys.

And so that’s going to be primarily my discussion with you today. I don’t know if you happen to see the recent article that’s out of Newsweek that’s actually centered right out of here out of Boulder with Douglas Elementary and some of the issues surrounding boys and how K12 education is tending to fail them.

The problem is, I think, that what we have done is change the basic structure of K12 education since we’ve gotten so involved with standards and how we educate students to C-SAP testing and different types of testing that we have forgotten to allow a process to be critical for how boys want to learn in K12 education so that we do not staff them primarily into special education.

And so I would just like to read a little

bit from this article. For many boys, the trouble starts as young as five when they bring to kindergarten a set of physical and mental abilities very different from girls. As almost any parent knows, a five-year-old girl are more

affluent than boys and can cite, read more words. Boys tend to be better and hand/eye coordination. But their motor skills are less developed making it a struggle for some of them to control pencil or a paintbrush.

Boys are more impulsive than girls. Even if they can sit, they prefer not to or at least not for long. It says in elementary school classrooms where teachers increasingly put an emphasis on language and a premium on sitting quietly and speaking in turn, the mismatch between boys and girls has become painfully obvious.

Girls’ behavior becomes a gold standard says Raising Cane co-author Thompson. Boys are treated like defective girls. And what has happened as a result of that -- and especially with the advent of lyE-A in our country which is basically -- now, in its second generation of concept in this state, we are creating a problem by dramatically overstaffing boys into special

education, not for cognitive reasons, but for the method in which we educate these kids in a Kl2 system.

In Colorado, for example, in all of K12

education, boys make up a 67.8 percent of the staffing

being staffed into special education. If you took a look at the reasons for cognitive staffing into special education, which would be autism, blindness, deafness, those types of things, you would find that the staffing is virtually equal across Colorado in how we staff boys and girls into special education.

But when you take a look at how we staff boys into special education on a behavioral reason, we overstaff them dramatically, and especially frankly in the minority population, sometimes as high as seven to eight times their population that they represent in Colorado schools, we overstaff minority boys.

For example, special education is tended to create the fact that over two-thirds of children with learning disabilities are always boys. It’s because, I, think, of the process on how we overstaff them. And over 90 percent of children labeled behaviorally disabled are boys.

And what that generally requires or comes down to is the fact that we start to put a stigma with boys that because of their behavioral method that they would choose to want to learn what happens in K12 education, the way that would be best for them is wrong.

I see I’ve already had somebody stand up. Also let me just tell you how that goes on further with AP courses. For example, in Colorado last year 20,435 students took AP courses in this state. Only 8,795 of those were AP. We have a current trend in Colorado based upon all our higher rate institutions that only 43 percent of students are boys that are going on. 57 percent are girls.

Let me just give you quickly three concepts, I think, that need to change in Colorado and nationwide if we’re going to solve the dilemma of trying to help boys with this area.

One is we need to change the way we do elementary education and fundamentally change the process of giving more hands on. There is some experimentation starting in Colorado with single-sex middle schools.

i James Irvin Charter Middle School, for example, in

Colorado Springs is desegregated the boys and the girls to give better enhanced opportunity for learned.

And then finally in tying with what Randy also talked about, I think there needs to be a lot stronger emphasis on career education and high school especially among minority boys because of the horrendous dropout rates we have in Colorado, some as large in some of our school districts. Two-thirds of all boys are dropping out of high school because they see no connection.

There are some high school models that are doing a good job. High schools that work is a model that is being done. I think we need to find a way to involve the concept of what a meaningful job in both science and both allows for students in K12 education.

We have to find some way for those boys to have an opportunity to have a connection, especially at the high school level, or else this is going to become a general problem that will continue to go on.

And as you take a look at especially trying to find male students interested in going on to these type of high-paying jobs which we want to have them

in Colorado do, we have to find a way for us to accentuate their normal behavior, destaff them out of special education, and give them a realistic opportunity to succeed in K12 education. And I’m sure I’ve violated my five minutes. Thank you very much.

DR. BEERING: Thank you, sir. I wish that your experience were unique. It’s unfortunately very common around the nation. Any questions or reactions? Yes, Ma’am.

DR. VASQUEZ: Yes. This question is for

Mr. DeHoff. Joanna Vasquez. I wanted to ask you -- one of the comments you made was about perhaps looking at paying science teachers, math or science teachers more. And some states where they have tried this -- of course, it’s an uproar from the community. A kindergarten teacher would say, I do as much work as someone with a lab coat in the sciences, et cetera.

So what is your feeling about that, and what have you -- what reaction have you had in Colorado to that proposal?

DR. DeHOFF: I don’t believe anybody’s given it a lot of serious thought because they’re afraid

of the reaction. But it’s one of those things that somebody -- one of these days we’re going to have to step up to the plate. You’re simply not going to get enough math and,science teachers in the classroom if you are

- going to pay them the same as a kindergarten teacher.

That’s not saying the kindergarten teacher doesn’t work just as hard. I don’t dispute that. But it’s a market economy. And if you’re asking to do something for $25,000 a year, which is a typical starting, salary in a lot of Colorado, when they -- you can’t live on that salary. They could be making 50 or 60,000 doing a job that really can be just as much fun. It’s tough to get them in.

DR. VASQUEZ: Well, I agree with you. I just wondered if your experience had -- if you had any experience with that.

DR. DeHOFF: One of the things I suggested is maybe a way around that is with an internship in industry so that the teacher’s salary is the same, but now they’ve got an opportunity during the summer or while off or taking one or two year sabbatical to go into industry and see the higher money, go back into teaching.

Very striking compliment, and
didn't really have time to
stions. And I'd like to hear
One is this early segregation
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And I think you would -- the teachers who are in there because they love teaching and, yet, would like to make some more, that may give them an opportunity to get more of those.-

But you're going to have to do something to raise salaries, and it's not just ra everybody and we'll solve the problem.

DR. BEMENT:

you're certainly right. We expand on two of your sugge a little more about them. by gender, and the second particularly minority.
-Could you develop us those a little more segregation for how long, how would it work, et cetera, and how to get those role models.

DR. DeHOFF: Thank you. Part of interesting aspect of this article that I think about with the crisis of boys is as they take a the development of the brain in a boy compared there tends to be in the puberty time frame or school time frame for boys a larger disconnect brain is developing at that particular time.

And as a result of how that is developing, it tends to create a little bit more of a struggle for them in that particular time. And so I think with the

- segregation of classrooms and some of the segregation that you have there, you have an ability to change and differentiate the style of educational programs that you would do for boys in a middle school which would be very much hands on. And one of the books that has been written about this, The Mind Of Boys, which talks about the development of boys' brains and how different it is from girls' brains, specifically deals with the middle school concept in a different type of hands on type of more action oriented type of middle school that would be much more enticing and much more promising for boys than it would be for girls.

What we find in K12 education is at the grade level that we seem to have the highest dropouts is ninth grade. And if you take at especially minority boys and why they are dropping out at that grade level, it's because they are not anywhere close to grade level on math skills. And I think what we need to do for middle

school boys in relationship to math skill processing is to make it something that is more involved with real world type of activities as opposed to simply mathematical formulas by giving them a hands-on type of approach to do that type of learning process.

And I think if we could then show the boys as they go into high school the practical outcome of a career and meaningful opportunity for them to accomplish something, if we could remediate that problem in middle schools and get the boys up to grade level, that we would -- we would have a lot better opportunity to succeed.

I happen to be the one republican legislator in the nation that serves on the National Assessment Governing Board, NAGB. And if you take a look at the NAPE assessment and what is happening generally speaking at the eighth grade level in NAPE math assessments across the nation, you find this is a systemic problem that we have across the nation that then plays out in the 12th grade assessment also with boys.

And so I think fundamentally using a different approach of education would work ‘better for

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those people.

DR. BEERING: Thank you. I wonder if our two other panelist may have come in, Susan Windels and John Evans? No? Our next reactor is Dr. Hoffman again and then Dr. Sullivan.

DR. HOFFMAN: I have a question for each of you. Representative King, as you know, I am a big fan of separate education for boys and girls having gone to a woman’s college. And I greatly appreciated the opportunity that gave to me. And I’ve seen the benefits for young people that I have known who have gone to private boys’ or girls’ schools. But there have been incredible legal challenges to your proposal when it’s been tried in other states. Do you see this as a real possibility here in Colorado?

DR. KING: Well, it’s actually been done

in James Irvin Charter Middle School in Colorado Springs since the inception of that particular school which has -- it’s probably in its third or fourth year now. And the kids get together for lunch, and they have different types of things.

But the main problem that we have that we

have to solve in middle schools is the fact that we are overstaffing boys in the elementary grades, and we have -- they get behind in math. And we have to remediate their math skills. And I think what this approach allows us to do is to catch up those boys, especially minority boys, who are not staying caught up and do true longitudinal assessment on those students as they go through middle school and get them up to the place where they are doing well.

So I don’t think there is a -- as long as this -- this particular school allows boys and girls, and they have virtually equal enrollment. But from the comments that I’ve heard from it, it’s been very supportive by the parents who are involved in the school because they see a different method of teaching boys and girls, and it’s making a lot of sense for them. So I think the legal challenges have been fine.

DR. HOFFMAN: That’s very good to hear. In fact, I agree with you. I certainly agree with you that that kind of experiment needs to take place at lower grades to the benefit of both boys and girls.

DR. KING: Thank you.

DR. HOFFMAN: Mr. DeHoff, I’d like to go back to the question that Joann Vasquez asked. This is something that we highlight in the companion piece to the indicators in which we issue kind of a grand challenge on K12 education. And one of the things we emphasize is the fact that science and math teachers are underpaid relative to their other opportunities in the work force. And then that may be one of the major reasons why we have such a shortage of math and science teachers.

And I know that you don’t really have a solution to this, but I wondered if you thought perhaps the legislation that’s now going through congress and the proposal that was in the President State of the Union Address to do it up front in the sense of giving scholarships and loan forgiveness programs and special incentive programs to students who enter math and science teaching might be a start in what I think we all think needs to be a long-term change in the compensation of teachers.

DR. DeHOFF: That would certainly be a big help. Again, looking at someone who’s gone through CU as II a science or engineering major, looking at a job offer

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doing that for 10 or 15 something else into the through a full-blown te have almost no evidence difference for how well

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particular -- we’ve got
a school direct, and in four years of school district when waiting for you there.
ing mathematicians and retiring, they’ve been they want to try without requiring to go ration program which really make a the classroom. t the rural areas in districts in Colorado
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from industry and a job offer from the loans and that has accumulated college, it’s tough to go to that you’ve got that other opportunity So that would be a significant help.

Again, programs to -- I mentioned teachers
and Teach For scientists or
America even if

to get retir they’re not

years and classroom

acher prepa that they you do in you look a 178 school
100 of them have less than 500 students K12, over 100 of them. It’s tough to get science teachers out in those areas, so we need to look at job sharing, at new ways of delivering instruction through Internet distance learning.

And, again, I think that’s an area that industry can step up to the plate and work with schools

to help out. I wanted to make one comment on the segregated sexes education. I think we need to do more of that. One of the school districts here, Sheridan, just south of Denver has been doing that in their middle schools, in their math classes, for a couple of years very successfully.

The Illinois School of Math and Science and Technology, I think it’s called -- it’s a magnet school, statewide magent school for math and science -- tried for a couple of years offering single sex classes in physics.

Dateline did a feature story on it. And

amazing was the different teaching styles and styles that you needed in those two classes.

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what was learning
The boys tended think out loud, who’s the first and very individual. The girls cooperative learning, thinking anything, wanting to make sure right or wrong, but they are ye you’re teaching one way or the
to be very competitive, one to get the answer, tended to do the through before they said they’re right. One is not ry different. And if other, you’re not going to ‘-- you’re going to turn off the ones who don’t learn

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that. So we need to do more to provide those opportunities.

Dr. BEERING: Dr. Sullivan.

- DR. SULLIVAN: Yes. I’d like to thank you - both for your comments with the knowledge and wisdom behind them. I’d like to endorse -- add my endorsement to this. Single-sex education concept is something that needs further refinement. But two questions in particular for Mr. King.

You mentioned and highlight the need to give boys, in particular, more hands-on inquiry oriented experiences. I’d be interested in your sense of the research vis-a-vis the value of that teaching methodology across the gender lines in terms of science and math teaching.

And the second questions that I’d be interesting in hearing a comment from each of you on -- I’ve just recently been reading some public opinion research work done by Public Agenda. And as a disheartening counterpoint to the sense of the conversation in this room, it points out that a very large percentage of both American parents and school

students do not see math and science improvement as anything like as critical an issue as the -people in this room perhaps would think it is.

, They have many, many, many other issues and concerns about their schools that rank far higher than that and tend to feel confident that what they are currently getting will adequately prepare them for the future.

My question to each of you on the government side of this quandary is: How do we -- how does a small collection of leaders or people in a room like this make some progress on this systemic issue for our nation if, indeed, that is the grass roots view of the parents who elect us all, appoint us all -and come to each of the PTA and schoolboard meetings.

DR. KING: Well, thanks for the questions. I think what we have done in CSAP in Colorado and particular on our 10th grade math assessment is just not work with how kids can solve mathematical problems. What we’ve tried to do is make them more word-type oriented problems so they have more practical applications to the world.

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And I think what has happened and a trend that we need to find for an adequate solution to this particular issue is how to find as we conform to standards based education that we make those types of activities more real to the world as opposed to just strictly academic ability to calculate formulas and make it interesting to the students so that they see some real connection.

One of the biggest criticisms that I hear about CSAP in general is that we evaluate what kids know, but we don’t have any sense of destiny for the kids in how well they can take that knowledge once they are able to understand the concept and apply that to the real world.

And so I think that that is an issue that we have with standard-based education across the United States is the ability to connect that, ability to make it more understandable, the ability to make it more practical for kids.

So I think girls could also benefit from that, but I think dramatically especially as the mind of - a boy is developing in middle school, it’s critical to

find more engagement for that particular child so that they are interested in doing it. Randy may want to comment on that.

- DR. DeHOFF: We definitely need to do a better job of it. And I think part of the problem is illustrated in the response we’ve gotten in Colorado to the higher ed commission establishing admission requirements for the state, colleges, and universities, which included four years of math and three years of science.

And a typical reaction even from those in K12 education is, well, not everybody is going to college, why do they need that? One opportunity is to get the professional trade unions on board with us because if you went to be a plumber or an electrician or a bricklayer or carpenter or any of those trades, you can’t even get your foot in the door for those training programs if you haven’t had Algebra II and in many cases Trig.

So we’re not talking just college. We’re talking postsecondary success. And we need to get that story up.

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And the other part, I think, kind of goes back to an informal survey I’ve been doing for little over 30 years now when I went to college as a physics major and people said, What are you majoring in? And I said, Physics. Nine out of ten of them go, Ooh, physics, I hate physics. And then you get that one that’s, Oh, wow, I love physics.

So I started asking them, Why do you feel that way? And for 30 years the answer has been my high school physics teacher. And if their physics teacher was somebody who stood in the front of the room and wrote formulas on the board and taught physics, they hate physics.

If it was somebody who made the connections, who showed them day by day how this plays out in your everyday life and makes a difference and then also opened up those career opportunities, if you want to major in physics, you don’t just have to be a white-coated lab physicist. You can do almost anything out there and get them aware of that. That would help.

And finally we need to improve the K8

curriculum because for too many students, particularly

minorities, by the time they enter ninth grade, they can't even think about going into math, science, or engineering and higher ed because they don't have the math skills. And there's no way they can catch up in high school.

If they're still taking remedial arithmetic in eighth grade and aren't ready for algebra or have already had it, they are not going to get into math and science. So it's not a higher ed or secondary problem. It's a KB problem.

MR. KING: And just to address your second question a little bit more, we have such a dramatic problem, I think, in the middle school, and especially in relationship to boys. This is across the gender lines in Colorado, but over 30 percent of all students who are going on to college in Colorado have to take remedial courses. And basically that's eighth grade math.

And part of the problem is the fact that we have not engaged students in the middle school curriculum across this state to adequately engage them and help them be able to accomplish basic math skills to the place where they can go on to college.

And so they get discouraged when they go on to college because college no longer is a four-year experience. It becomes and five- and six-year experience.

- And what we need to do in Colorado, in my opinion, is expand postsecondary options type of curriculum efforts so that we can remediate these kids as a senior so that when they are leaving high school, they're adequately prepared to go on to college, and they feel that they can be successful in math and science curriculum and they don't feel like they have to sit there and sometimes take a remedial course two to three times to be successful.

DR. BEERING: Let me thank you two panelists, and we managed to take up all the time as you predicted.

DR. KING: I'll tell my colleagues in the general assembly I enjoyed using their tame.

DR. BEERING: There you go. Thank you both. Our next panel consists of Cindy Stevenson, Cindy Moss, and Timothy McCollum. I invite you to come to the table.

All right. Welcome. Thank you for coming. We’ve got both of the Cindys of Boulder coming here today. Would you like to start, Cindy Stevenson.

Dr. STEVENSON: I would be delighted. I’m Cindy Stevenson. I’m superintendent of Colorado’s largest school district, Jefferson County Public Schools. We have approximately 86,000, K12, and we have approximately 5,000 teachers. So I speak with great pride about K12 and about our school district.

I would like to start at an end point. finished Thomas Friedman’s book, The World is Flat over the Christmas holidays. I felt like it only took me seven years. If you have read it, I hope you felt it took less than seven years. It’s long; it’s complex, and he speaks a lot about science and math.

But I was very glad when I got to the very last page that I stuck with it because he has this quote: He’s speaking to the generation of 9/11 which I would consider our teenagers and our 20-somethings. And what he says is, Be the generation of strategic optimists, the generation with more journeys than memories, the generation that wakes up each morning and not only imagines that things can be better, but also acts on that imagination every day.

What I would encourage you as an influential panel is to remember that education is more than skills, more than content. While both of those are very important, it is about creating students who have dreams, who have imagination, and who do go out and solve problems. I thoroughly believe that math and science education are central to that dream.

In math and science, children need content and they need skills. But how do we get to the content and skills. Good teachers really matter. You've heard lots of conversations so far about attracting people to the profession, paying people more for math and science.

What I want to talk about what is what do we do to make sure we have the best and the brightest with every child. And what does that look like.

What that looks like is people who do know their content, absolutely thoroughly and deeply know their content. Second of all. They have a passion for what they're doing. And they come to work every day with the support they need to make a difference in children.

A critical element of that support is ongoing training.

So we can speak about preservice. Yes, we need excellent preservice. But once they graduate and we have ouryoung 20-something teachers, they’re not fully - formed. They have a lifetime of learning ahead of them.

If they’re going be excellent with children, learning has to be at the core of Kl2 science and math education, our ongoing professional teachers. Because they’ve been at it for 20 years, doesn’t mean you stop learning.

And finally you hear lots about let’s attract industry professionals to education. We can do that. We have good alternative licensing programs. But let’s not believe that they, too, don’t need staff development.

So I really want to stress good teachers matter. Now, the federal government has implemented part of the no-child left behind funding. There is a title too called Quality Teachers.

Jefferson County with 86,000 students, 5,000 teachers receives $2.5 million with that funding. We had a meeting yesterday to try and decide where it went. You can imagine the dilemma, do we invest it in ESL teachers, do we invest it in science teachers, do we invest it in math teachers, do we invest it in first-year teachers?

When you have 5,000 teachers, 2.5 million does not go very far. So whatever influence you have, what can we do as a country to invest more in our teachers. Good teachers matter.

Second of all, I want to talk about that imagination and that creativity. I’m an absolute believer in skills and content. I would love for all of our kids to take four years of math and four years of science. But let me talk a little bit about how I know when it’s working, and I’m going to talk about technology.

Kids come to us now -- they’ve basically

and our teachers have all been k fast. Our teachers have all been those kids know more of the hey do, and that’s okay. Here’s what able to do.

need to -be able to teach kids about

21st Century kids, worried -- I’ll tal worried because all technologies than t teachers need to be

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And I will stop, but it is the subject about which I am passionate. Thank you.

DR. BEERING: Thank you very much. Your threatening presence has done it again.

DR. STEVENSON: You are threatening. I need you at our schoolboard meetings.

DR. PEERING: He rents out cheaply. You

can -- may I ask Cindy Moss, Director of science K-12, Charlotte Mecklenburg Schools to go next.

DR. MOSS: Yes, thank you. I’m addressing you today as a science educator who spent 21 years in the classroom teaching biology and chemistry to some extremely brilliant students and also some very needy students. As a teacher researcher, I conducted research on which factors in that learning environment in the

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truth in technology. technology to discern truthful information. information should be and analyze, and how fashion. That takes teacher training.

How do you teach kids to use truthful information from not

What information is useful, what discounted. How do you synthesize

do you do that in a collaborative great teachers and that takes

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classroom would lead to higher test scores on our state test and then use my findings to do an intervention.

In the intervention year I told the other teachers to give me the students they didn’t want. And so they gave me 90 students they labeled definite failures. And through inquiry, mentoring, and relevant experiences, I enabled those students to succeed. These minority and free and reduced lunch students not only succeeded, they outperformed our school's honor students and are now all in their second year in college, about 50 percent of them majoring in science. So I know personally that all kids can learn science and succeed.

For the past two years my charge has been to equip our approximately 15,000 teachers in Charlotte Mecklenburg with the tools they need to succeed with their students, and it's much more difficult than doing it myself.

The barriers that I've encountered are many. The number one barrier that I see preventing students from having a true science joy of inquiry experience is the type of assessment that most of our states use.

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These multiple-choice tests are the driving force behind the kill and drill, sage on the stage teaching that we see occurring in most American classrooms today. As I visit classes in our 143 schools, I see students sitting passively watching their teachers disseminate information. These students show up every day. They’re waiting for something good to happen and to be actively engaged. Instead they’re taking notes, reading their books, and taking multiple choice tests.

In many classrooms the students aren’t even permitted to ask questions because the teachers have to cover all the objectives. When I speak to these students, they tell me science is boring and hard. In my opinion, the situation is educational malpractice and must be addresses.

So how can you and the National Science Foundation and the National Science Board help rectify this situation? State testing is driving educational decisions. And my state in North Carolina, only math and reading have been tested for the past 12 years at the K-8 level.

So our elementary teachers are only

allowed 45 minutes each week to do science and social studies if all their math and reading objectives have been met.

- In our North Carolina middle schools math and reading have been double blocked and so science classes have become remedial math. Our students reach high school having had no science K-B. And in North

Carolina at the high school level, five of their nine required tests are science. So we've created a train wreck.

We do have national standards in science, and most states claim that their tests are aligned to those standards. However, success on those state tests usually may be achieved by only wrote memorization of facts or formulas.

These tests do not focus on the skills that were outlined in the national standards. If we remember the saying that which is measured -- that which is treasured is measured, the National Science Board can initiate and spearhead the design and implementation of national tests and fifth, eighth, and tenth grade that really require students to do science.

They would do inquiry, collect, and organize data, analyze and evaluate it, discuss it with others, and then decide how they would defend their conclusions.

I fully realize this is an expensive proposition. But the future of our country stem industries are at stake here. We're currently spending billions of dollars with dismal results, and so a radical change in science classrooms is desperately needed.

Besides the cost of developing, implementing, and grading these tests, professional development for teachers and administrators is necessary as well. This is a perfect opportunity for the business community to partner with our schools.

School personnel need to spend time in businesses seeing the skills that are really needed and STEM careers and the amazing opportunity for their students in those careers.

Recruitment and retention of science teachers is another major issue facing schools. I lost five chemistry teachers last week, so if you have some, you can send them to me.

In North Carolina our starting salary for teachers is 29,000. So a college student willing to tackle difficult chemistry and physic classes rarely go into teaching. In our entire state only four people certified to teach physics graduated last years. And you heard the statistics from Colorado.

The pressure of the No Child Left Behind in state testing is a reality. So we need to find a way to use it for the good of our students.

We have no trouble recruiting young people to play basketball or find adults willing to work for pennies on the hour as coaches. That’s because the challenge of performing on the basketball court has real world relevance and the possibility of a future career, even though it’s slim.

This makes the hard work necessary to be a successful basketball player worth the investment of time and energy.

If we’re to make major changes in science and education as a country, we have to find ways to reinject excitement into the science game. Currently we’re experiencing the agony of defeat because our

schooling process has conditioned away natural curiosity.

Our students will rise to the challenge of the science game if we give them the opportunity to experience the thrill of victory and tackling real world scientific questions. Thank you.

DR. BEERING: Thank you very much, indeed. Next Tim McCollum, 7-12 Science teacher, Charleston Middle School.

MR. McCOLLIJM: Mr. Chairman, members of the board, fellow panelists, distinguished guests. I am deeply humbled to be invited to contribute to such a significant event as this hearing on improving both the quality of teaching and performance of our nation's students in the areas of science, technology, engineering, and mathematics.

Seldom does a classroom teacher have the opportunity to participate in an initiative of this magnitude. I would remind the board, however, that my role as a teacher may be the most important role represented here today. After all, I am probably the only one in this room who needed to arrange for a substitute in order to attend.

Through my involvement with various educational organizations, I have come to appreciate that our nation’s schools are blessed with an abundance of outstanding teachers and exemplary programs.

Unfortunately these success stories are seldom made known to the public. In addition, many master teachers are retiring, and the need for attracting the best and the brightest into science and math education has never been greater. This is particularly true for males.

Male teachers are becoming an endangered species, especially in elementary schools and middle schools.

In order to meet this need, salaries for science and math teachers must begin to rival those available in the private sector or in school administration -- another career option which often draws our most capable teachers out of the classroom.

Establishing differential pay scales for math and science teachers would be a positive step toward attracting our most capable candidates into STEM education. -

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The inquiry remodel for science education is a prominent component of the National Science

Education Standards. Teacher education programs must model this approach within their own curricula if it is to be effectively integrated into K-12 education.

Future teachers must understand the importance of doing science rather than simply learning about science. With access to more and more quality resources on the Web, effective teachers are moving away from textbook-centered curricula. Online resources and digital libraries not provide students and teachers access to data that was once within the domain of research scientists.

Fostering the movement away from content-heavy instruction and toward inquiry and application will surely lead to more productive citizenry that is better prepared to solve the problems of this century and beyond.

While I applaud the goal of No Child Left Behind to raise the performance of all students, the resulting emphasis on high stake’s testing has often led to the unintended deemphasis of science instruction and

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performance in favor of an expanded emphasis on reading and mathematics.

At a time when the quality of science education will directly impact our future standard of living and even our national security, science has unfortunately taken a back seat to reading and mathematics.

More and more science teachers are being assigned to teach subjects outside of their trained discipline. This growing practice often results in larger science sizes, less time for science preparation, less funding for science supplies and professional development, and sadly, a diluted passion for teaching.

One would consider it absurd for a reading teacher or language arts teacher to be assigned to teach a chemistry or physics class, yet science teachers are often expected to teach other disciplines.

Sciences as discipline must be elevated to a position of higher priority in our schools. Failure to do so will surely lead to a continuation of unacceptable condition of K-12 STEM education in this country.

Finally, the loss of federal funds for

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science education such as the Eisenhower program has severely curtailed opportunities for professional development. Meeting with ambitious and motivated members of the profession and gaining fresh ideas from workshops and conferences have very positive effect on one’s teaching performance.

Many teachers seeking such opportunities are now faced with paying their own expenses and even paying for own substitutes. Like slide rules and 16 millimeter projectors, professional travel funds for science have become a thing of the past.

Fortunately, exemplary programs like the Presidential Award for Mathematics and Science Teaching, Toyota Tapestry and Exxon Mobile Building a Presence for Science provide special teacher recognition and funds to support innovative programs.

A renewed effort to establish funds for professional development and professional travel would go a long way toward improving the quality, resourcefulness, and enthusiasm of science educators.

In conclusion, the charge to the Commission should include strategies for, One,

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establishing differential pay scales for math and science teachers. Two, fostering the movement away from content-heavy instruction and toward inquiry and application. Three, re-establishing science as a priority discipline in relation to reading and math during this era of high stakes testing. And, Four, reviewing federal funding sources to support professional development in STEM education.

Borrowing from the words in Chairman Washington’s invitation to this hearing, these strategies are essential to future U.S. eminence in discovery and innovation. Thank you.

DR. BEERING: Thank you very much, indeed. Reactions from our group.

DR. HOFFMAN: I’d like to ask two questions of the group, whoever would like to answer or all of you. One of the challenges that we’ve all talked about and you just mentioned was the need to increase the~ pay for science and math teachers commensurate with their outside opportunities.

I think you all are appreciative of how difficult that is in the current unionized environment.

And I would like some thoughts from you as to how that might be -- how we might go about doing that. You talked a little bit about the incentives up front, but that doesn’t address the long-term problem.

And then the other issue which Dr. DeHoff brought up in his testimony is the alternative certification. And, Dr. Stevenson, you mentioned we have lots of opportunities for alternative certification. I’d be interested in hearing what they are.

So those are two, I think -- they’re ducktailing issues because they address the entry of teachers and the young end, but they also address the opportunity to recruit people who have made their money and may have a passion for teaching for teaching who might wish to come back later.

DR. STEVENSON: I guess I would advocate
we have a very strong teachers association in Jefferson County as you well might imagine. And I would advocate a bit more complex situation than simply paying math and science teachers more. I think the entire issue of teacher compensation needs to be looked at deeply.

- And I think it’s a fallacy to say we’re simply going to pay people more and not mention what kind of results they’re getting.

So while I understand the market forces, market forces strike me as one of the factors we need to consider in an alternative compensation system, market factors results that teachers get, what kind of training do we have. I think the system needs to be more deeply looked at than simply that competitive piece.

The second piece around alternative licensing in Colorado, we have teacher and residents and we have alternative licensure. And those programs do bring professionals into the classroom. They are teaching, but they are closely mentioned, closely monitored. We work with universities, and they are taking classes and teaching and have lots of supervision.

And so I think it’s a context-based program. And we have had success with it. I do believe it’s a fallacy again simply to say you can pull someone out of industry, put them in a classroom of possibly 30 16-year-olds and think it’s going to automatically work.

That person needs support. Yes, they have the deep content and the practical experience.

16-year-aids can somewhat do unexpected things frequently. So I think that these situations are manageable, doable with the right heart and the right spirit, but they’re not simple.

DR. MOSS: I would also like to say we do not have unions in North Carolina. We’re a right-to-work state, so that’s not an issue. But I worked in New York with unions. In general, I don’t even think most science teachers are looking for more pay. It’s a lot about opportunities.

One of the things we started doing in Charlotte is last summer we had 25 science teachers who were given the opportunity to do four-week internships with businesses where they made $1,500 a week. Businesses apologized for paying them so little. We were afraid we were going to lose them, but they came back because that was a great way to supplement their income. They now had a chance to do other opportunities.

I think there’s some other things that you can do for people that are highly motivated. In terms of alternate certification, we’ve really struggled with that. In Charlotte we get new kids all the time. And so

we’re constantly looking to hire new teachers. We have a lateral entry program in the state of North Carolina.

If you have an undergraduate degree in science in whatever area, they go to a four-week summer training. They do a 10-day boot camp that’s all about the general -- how do you take attendance, all the things that teachers have to do that nobody else understands, and then they take four graduate classes.

But the most effective part is we have science content coaches. I have seven full-time people who work once or twice a week with those new people helping them write lesson plans, call parents, figure out what’s going on, deal with those 16-year-old hormones in the back of the room. And before we had coaches in place, we would lose about 70 percent of our second career people. With coaches we’re retaining about 90 percent. So there’s lot of complex issues involved with this.

MR. McCOLLUM: Both of my panel of colleagues have very valid points in terms of the issue with differential salaries. There is no easy answer. -I r would say simply that the present system is not working.

We need to think outside the box, look at ways we can bring more people in. In all of these different reports and discussions, I’ve read different testimonies that talk about teacher training and inservice, free-service, preservice, and so on.

We need to get them first, and we need to provide incentives. The University of the State of Illinois is the Number 2 producer of teachers in the State of Illinois. And prior to this hearing, I spoke with the Dean of the School of Education to get some numbers for graduates. And the Number 2 university, the University of the State of Illinois, for creating future teachers averages three physical science teachers per year for the entire state.

So the numbers are incredibly small. What can we need to do -- it’s not a matter of one discipline having more value than the others. In our community, there’s heart surgeons and baby doctors, no one would argue which one is determined to be more valuable. Others mentioned in the last panel that it was simply a matter of economics, supply and demand, if we continue to do the same thing, we’re not getting different results.

We need to look outside the box.

DR. BEERING: Dr. Vasquez?

DR. VASQUEZ: Couple of questions. There’s a lot of talk -- we know that the content knowledge of elementary teachers is mostly lacking in science particularly. Would you support in endorsing a science specialist or science league teachers that would teach most of the science to the students? And I throw it out to all of you. That’s one question I have.

DR. STEVENSON: I probably would endorse more having ongoing context-based staff development for all of our elementary teachers. I think it good to have an elementary teacher who has math or science degree, absolutely. I think we should encourage that and work towards that.

On the other hand, I think that the elementary teachers stay -- and if you think about relationships with children, they really do have to be experts in literacy and mathematics and science and social sciences. In order to do that effectively and sustain ongoing clear relationship with children, I think you need lots of development of teachers in the content

have to attend to.

DR. MOSS: I think that in Charlotte what we're trying to work toward is one sciqnce specialist at each school not to teach all the science, but to help the teachers do what they're doing. We just went through a textbook adoption, and the program that we adopted is also kit based. We trained 3,000 elementary teachers for three days last summer. And for the first time ever, we're seeing science happening.

Our biggest barrier is they're only given 45 minutes a week if they're not finished with reading and math. Where we need help from this kind of group is -- I mean, it seems ridiculous I want to write a letter to the newspaper and tell the taxpayers I spent $6 million on K-S education and they're getting to do it 45 minutes a week, but I would be fired for that. But this is where this kind of group could help us. Kids need a well rounded education.

MR. McCOLLUM: I think our teachers are expected to be jacks of all trades. Oftentimes science is the area that they feel the weakest in, and it obviously gets the least amount of attention focus. The

area.

So what we do is we have rebuilt our science curriculum over the last five years. And we do what, for example, scoring conferences. We do imbedded assessments in the curriculum that teachers administer. Our teachers come together, look at student work, and say, What is this say to you about what you are teaching, what you are not teaching, and how do teach it? And that also enhances the content knowledge.

Because as you're looking at an assessment, for example, on rocks you're thinking about, How do I teach it, what else do I need to know? I do think content knowledge is essential. And anything you read about great teachers, deep content knowledge is a piece of that. And I think it is in the elementary schools, it is a piece that school districts have to work very hard on.

I'm not necessarily an advocate for one person teaching the science because I think the success for kids almost founded in relationships. And I think in a classroom, those relationships get very strong so I think it's a dilemma. But I also think it's something we

content value is highly valuable. Going along with that content knowledge would be, as we've all mentioned, the importance of inquiry and looking at the classroom.

DR. VASQUEZ: I have one other question, if I could ask that of both Cindy and Tim. If you were to have your choice about saying that the National Science Education standards should be adopted as the standard for everyone so that every state -- as we all know, each state takes the standards and then does it. And then each district takes the standards and redoes it, so it becomes a mixed bag.

Would you say that that if we had one set of science standards and we one test that would test those standards -- if it was the NAEP or if it something else -- would you endorse that? Or why or why not.

DR. MOSS: Yes. That’s exactly what I was talking about. I would love to see one test -- we already have the NAEP. I was looking for something more hands-on. In New York, the fifth graders took a test -- they would open up a box of stuff. And they had an hour to put it together, do some kind of experience. And then they had 20 minutes to share what they’d done with their neighbor.

They talked about it and then they wrote about what they learned based on the collaboration of what the other people did. When I say it was very expensive, it takes a lot time and effort, but that’s real science. A kid can’t go in there and perform successfully on that test without doing science during this year.

I think we need just the one tests -- when I lived in New York, we had the regions because kids would move from New York, to Buffalo, to Syracuse. Well, now kids move from Syracuse, to Charlotte, to Boulder. think that the employers and the public has the right to know that kids have these skills they need to succeed. And if we had those real science standards, that would drive the instruction in the classroom.

MR. McCOLLUM: Part of those standards and those assessment are balance and application. As a society, we are more mobile today, and that has been brought out in records. Many of our students have been through several different school districts and different i states by the time they wind up in our own classrooms.

And oftentimes it doesn’t align at all between the different states. And I could see some real value with what you’re suggesting.

. DR. VASQUEZ: Do you think NCTN has done a better job of their standards as making them more of an equalizer than the science standards?

DR. MOSS: Yes, I do. I think that -- maybe because it’s math is more linear, but in general it seems like the math standards and the math -- the states have aligned with NCTM much better than they have with NSTA, the national standard.

DR. STEVENSON: And I have to say from a perspective of a local control state, Colorado dearly holds local control, I think it would be a struggle to have federally mandated science standards. I think there are a lot of things that could occur to encourage good standards. I go back to the incentives the way we look at kids, what we measure.

I think -- I would predict there would be considerable resistance to federal standards.

DR. BEERING: Dr. Sullivan has a question.

DR. SULLIVAN: You all have touched on

many points upon which this body can add its voice to many other things spoken to them. But many of these issues do fall peripheral to or beyond the realm in which. the science board and science foundation specifically can act. I wonder if in your thinking about these challenges~ and ways to improve our performance on them, if you come across any more granular specifics that you would either like to encourage the board and foundation to look at doing or improving or ceasing to do in the repertoire of things that we currently do to try to advance education and human resources in science, math, and education.

DR. MOSS: We're currently working with a group of businesses to have every science department in each school have a business partnership. And many of these businesses -- I know -- again, this maybe beyond what you could do, but you know lots of influential people. Many of these businesses have talked about tax advantages for being very involved in schools and incentives for them to become much more engrained in the educational fiber of what's going on.

MR. McCOLLUM: There are many outstanding programs that are in existence right now. Just an average teacher -- percentage of teachers that are going to employ those and look at ways of moving beyond the steps to look at, opportunities to make things much more real, tied in with authentic activities -- more authentic concepts and maybe what would be the textbook itself.

I think the big task is how to bring the rest of the teachers, those in the middle, those that feel so tied to maybe a text and are less likely to risk getting into the project in which there is not a teacher's guide with answers in the back.

DR. STEVENSON: I want the address your question to the last group about the national vision. In our work with the School of Mines one of the things that we've tried to figure out is how do you turn a community around. And I'll give you a couple of examples.

DR. HOFFMAN: I'm having trouble hearing you, and I want to hear what you're saying.

DR. STEVENSON: Yes. I want to go back to your last question about the vision of the community. One of the things that I have found consistently because I do considerable speaking to quantums and rotarians and all kinds of chambers, and we're a very large county.

When I speak about all kids being prepared for higher education in math and science, there's not a deeply held belief in a lot of communities that that is essential. And in working with the School of Mines, one of the things we've talked about at issue hear comments like, Well, math and science is really hard. That's too hard, or that that's for a certain kind of kid, math and science.

And I think there's a place for a national vision -- I know it sounds a little crazy -- math and science is for everybody. You don't have to be a special child to be good in math and science. Math and science truly is at the core of creativity. It's truly at the core of curiosity and discovery. And how do you make that part of our day-to-day life.

And that needs to permeate our society. And I think it's a really germane question about what kind of national vision, what kind of national leadership, what are we doing with our parent community, what kind of messages are we delivering about what you say to your children about math and science.

I And I do think there's a place for a group

such as your to influence the way we talk about these things on the national level, what we say, the messages we give, what kind of public service spots are on television.

I think we need to turn the thinking around of our entire community. This is for everybody; it is essential, and it does matter.

DR. BEERING: Dr. Bement.

DR. BEMENT: Yes. I've got a partial answer to my question, and thank you. I read a survey not too long ago which had a cohort of teachers who had left the profession who got their first degree in math or science and got their second degree in education because they were dedicated in education. And they were asked why they left the profession.

The one thing that surprised me was a large number of reasons. They were perhaps as many as 30 or 40 reasons. The one thing that didn't surprise me was that compensation was down the list merely because they went into the profession with their eyes wide open, but they were dedicated.

I And many of the factors that ranked higher

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than the compensation really had to do with early acceptance and early support. And many of the others were environmental factors in the environment in which they were teaching.

I wondered if you could comment on that.

DR. STEVENSON: Research consistently tells us that, that most teachers don't leave the profession because of compensation. They leave because of lack of support because they don't feel like they're being successful. We also know that when we look at what we call high priority schools, schools that, for example, have over a 90 percent free and reduced lunch rate, very difficult environments.

Teachers will stay where they are aligned and respectful of their leadership. When they look at a principal and say, I will follow that person anywhere, they will stay in that school. In fact, the research shows that when you offer greater compensation, most teachers will choose whether they stay or go based on the leadership ship in the school.

So I think leadership, I think support, I think the sense that I am making a difference, those

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through research and through our own experience have shown to be far more influential in whether a teacher stays, goes, stays in the building, moves to a different building.

So I do think -- I keep saying it’s a complex situation.

DR. BEERING: Thank you very much. Thank this panel for an exceptional set of statements and answers.

The next panel is Michael Barnett, Joseph Heppert, Thomas Smith, and Karin Wiburg.

We’re delighted you all are here. Let us start with Michael Barnett.

DR. BARNETT: Good afternoon. I believe we need to build professional communities that can provide the support to improve science education. I will mention a program that has been highly successful in building communities among teachers and even more importantly among teachers and research scientists at universities and laboratories.

This program is called QuarkNet and has for the past eight years built communities among these

groups with funding from NSF and the Department of Energy.

The concept started because the NSF and DOE are cofunding two physics experiments at the Large Hadron Co].lider in Geneva. These international

experiments have over 60 universities and labs participating, and these were the bases for the QuarkNet program.

In fact, over 50 of these institutions have chosen to be QuarkNet centers. A center is one or more universities or labs in a geographic area that are host to an ongoing community of two to six teachers and -- two to six physicists and 10 to 20 high school physics teachers.

The program gets teachers involved in the experiments and helps them use inquiry-based methods to teach physics. What I wish to emphasize is that the program has created meaningful interaction among teachers and scientists that has kept the centers alive for years.

To build a community, members should have shared interest and should have something to offer each other. The physicists have learned things from these

teachers, and the physicists have become mentors, allies, and friends with the teachers.

The teachers with initially attracted to

the program by the excitement of these vanguard experiments and they search for string theory to black holes to extra dimensions of space to dark matter. But it’s the communities that they’ve built that have kept this program alive.

I think it’s vital to recognize how isolated the typical high school physics teacher is with respect to their profession of teaching physics. QuarkNet has changed that for participating teachers who now come from over 500 high schools.

I would like to quote from some of these teachers from QuarkNet because they summarize very well just what they have gained by being part of a vanguard experiment of a university group and of a group of physics teachers.

“Association with QuarkNet has provided me opportunities to receive briefings and listen to presentations dealing with contemporary physics research. I take that information back to my classroom and through discussions bring the excitement of current physics to my students. I really believe I’m a much more well rounded teacher because of my association with the people involved in QuarkNet and not just the knowledge. Rubbing shoulders with these great researchers has afforded me opportunities that I never dreamed of obtaining. And the association of all these great teachers that have been involved in the QuarkNet workshops at each of these institutions has created a wonderful network of individuals I can contact. This has been truly one of the greatest experiences of my teaching career.

This program has enriched my teaching. have many resources to tap into now. I have a broader knowledge base as a result of lectures and research. have a warm web of friends across the United States with the same goals as I do and who are eager to help with encouragement and advise. I feel part of something larger, and I don’t feel like I am alone -- emphasize that word -- alone again in the classroom any more. I have had several students express an interest in becoming a high school science teacher like me because what we do is so interesting”

From these and many similar comments, I conclude that programs such as these can have a big impact on the isolation of science teachers and bring them into a broader community that enhances their abilities as teachers.

Equally important we have found newfound respect from students and their parents and from principals and others in their school systems. And even more it has created self-respect for these 500 teachers.

And after I wrote this, I actually noticed that in your first hearing that Gerald Wheeler of the National Science Teachers Association made some very similar remarks testifying that the biggest hole in the diet of science education inform is teacher content knowledge. But he also said they had polled their members and found that the biggest barriers they faced in teaching and the top three responses were lack of time, isolation, and lack of meaningful professional development, very similar to what I'm saying here. So thank you very much for your time.

DR. BEERING: Thank you very much, Dr. Barnett. Next, Dr. Heppert.

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DR. HEPPERT: Mr. Chairman, distinguished members of the National Science Board. I'm addressing you today as the chair of the American Chemical Society Committee on Education. It's my distinct pleasure to address the board on the subject of utmost importance to the future of our country at a time when this very subject, math and science education, is at the epicenter of a vigorous, healthy, and urgently-needed national debate about how to best maintain America's competitive edge in a global marketplace of the 21st Century.

Today this debate is extended beyond the halls of academia and the scientific community and is echoing across dinner tables, community centers, and boardrooms around the country. It has also unmistakably captured the attention of Congress and the administration.

The National Science Board and the National Science Foundation have an essential role to play in arising to the challenges we face in K-12 and undergraduate and math and science education.

These challenges include poor performance of our students on the science portion of NAEP, the pending retirement of the third of our teacher workforce, the decline in the number of students studying science and engineering, the decrease in the national science foundations education between the resources director of budget which has been reduced by 16 percent over the last two years.

NSF must embrace its unique leadership position as the only well-established bridge between scientific and education communities and assume a leadership role in the federal response to immediate

Your efforts to organize a formal these challenges.

commission that will study the challenges facing math and science education is timely because NSB and ultimately the NSF needs to adopt a plan of action that clearly reasserts its leadership role in math and science education.

For the record, I have submitted a copy of Science Education Priorities for Sustainable Reform, The American Chemical Society’s comprehensive statement on priorities, practices, and polices related to science education at all levels.

Iwould encourage the board to review the

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society’s recommendation on a wide range of science education issues.

I would like to focus my remaining remarks on two specific issues, the subject of research in the best ways to improve math and science education and the role of NSF in science education. As with every major challenge our country is faced over the course of our history, innovation will play a huge roll in improving math and science. We must expand our research efforts in math and science education.

We need new idea, new technologies, new curricula, new resources, and content materials and most of all new thinking on the whole subject. The nation has an ongoing need for research and innovation in math and science education because as we extend mathematical knowledge, develop new instructional technologies and uncover more about human learning, we must apply this new information to improve student learning.

Creating the world’s best classrooms, teacher preparation programs and learning methods is going to require a structured focused research effort on a fairly large scale. We do not know what works best in

every science classroom.

Education in general and math and science education in particular is a very complex undertaking involving a large number of variables. Therefore, we need to do what this country does so well, assemble a world class research effort with the resources necessary to produce real progress in an area of national importance.

The federal government puts substantial resources into basic research on energy. I’d argue it’s because it’s a critical national importance. I would argue that the quality of our educational outcomes preparing graduates who will be competitive in the high-tech workforce in the future is of comparable importance.

NSF must clearly be the lead agency in undertaking this crucial research task. And NSB commission could articulate a clear plan and mandate for rising to this challenge.

The second issue I want to address is simple and short. NSF must recognize that its educational mission is every bit as important to the nation’s future as its research mission. We must set aside the notion that NSF’s education programs are either subservient to or stand in competition with its research programs.

NSF’s education and research missions are mutually supportive and play key unique roles in building our nation’s scientific and technological capacity. I can’t emphasize strongly enough that NSP is uniquely situated as the agency best suited to bridge the distance between the scientific and education communities.

In responding to math and science challenge of our nation faces, we do -- if we do not take advantage of the unique strengths of NSF, we are making a mistake. There are many government agencies that play vital roles in math and science education, but the National Science Foundation should play the key role.

There’s no doubt that an NSB commission clearly marks -- that clearly marks this as a definitive goal for NSF would be taking a huge step forward in math and science -- the math and science education challenges our country must conquer.

In closing I want to thank the Board for

the opportunity to testify here today. We have important work before us if we’re to be successful in preparing our children for the challenges of the 21st century. Thank you.

DR. BEERING: Thank you very much. Let’s hear from Dr. Tom Smith next.

DR. SMITH: Mr. Chairman, distinguished members of the National Science Board. I want to express my appreciation for the opportunity to testify before you on the subject of K through 16, education and science technology, engineering and mathematics in the United States and the role of the NSF in this context.

Let me begin by saying like many of you in the room, I’m a product of the post Sputnik U.S. STEM education system. I’ve spent the bulk of my scientific career, however, as an industrial scientist, 28 years of which was with the Xerox Corporation in Webster, New York, where I was a member of the research staff, manager and research fellow.

I am currently a professor of chemistry and microsystems engineering at the Rochester Institute of Technology, and I’ve been part of the higher education

enterprise for about four years. I’m also proud to join this panel alongside my colleague, Joe Heppert, from the American Chemical Society.

I wholeheartedly endorse the establishment of a commission on 21st century education and science, mathematics and technology with a charter to reformulate a national strategy for implementation of an effective long-term approach to problems and opportunities in the U.S. K through 16 STEM education.

The NSF clearly needs a well articulated plan of action that defines a leadership role in the STEM education system. My contribution to the deliberations on the mission of the commission is intended to focus on an area of STEM education that I do not think has received sufficient attention; that is, the need to look at STEM education from the perspective of the ultimate customer, our students our children.

While numerous reports have characterized the status of STEM education in the United States, vis-a-vis that in competitive economies throughout the world, none has taken the perspective of our various student populations and analyzed the factors underlying

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the choices made by or for these students.

It may be that the recommendations and alarms of previous reports and statements from imminent bodies of academic and government industry leaders have largely been unanswered because the root causes of our continued slip in international assessment of achievements in science, technology, engineering, and mathematics have not been fully explored.

Much of the debate about STEM education has focused on concerns about U.S. competitiveness in the global economy of the 21st century and how we can best leverage the abilities of our best and brightest students to ensure our future technological leadership.

I understand these concerns, and I agree that we must rise to the challenges presented by a “Flat World.” The question that I raise, however, is to what extent is the number of our best and brightest students limited by the overall level of the scientific and technological literacy in the United States.

It may be that America’s competitive position in science, mathematics, and technology can be more dramatically improved by focusing more energy on

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increasing the overall level of competence in math and science.

In today’s education system, there is a clearly defined gap between the skills of the so-called best and brightest students and the rest of the student cohort. That gap needs to be closed. Modern workplaces whether in the sciences or elsewhere require problem-solving and analytical skills, in other words, scientific literacy.

As such, all students, regardless of career path, need a rigorous high school curriculum that includes at least three years of English, math and lab sciences.

NSB Commission should explore this important opportunity and STEM education and should emphasize that the NSF's fundamental education mission is not directed just to the best and brightest.

The NSF can and is contributing to improving the quality of STEM education. And while it's

only one of a number of federal agencies whose activities and programs must be coordinated in responding to the

challenge, the NSF plays the pivotal role in sustaining

America's technological leadership by fostering improvements in STEM education at the K through 12 undergraduate and graduate levels.

. By virtue of its constituency of educators and researchers at America's colleges and universities, museums and other educational institutions and industrial research enterprises, the NSF is uniquely positioned to address the improvement of STEM education.

I support the NSF as an education leader, and I think the foundation has great potential in spearheading the response to the STEM educational challenge. The NSB, through its proposed commission, can help articulate this leadership role.

In closing, I want to reflect a bit on my own experience with learning, invention, and innovation. In our focus on assessment and standards, we may have lost an appreciation for the importance of play, playful competition and success experiences in shaping the choices students make. I am an inventor, and I have come to know that play is the essential factor in learning, discovery, and invention. What I mean by play is not to engage in childish antics but playful and purposeful

manipulation and exploration of objects, materials, information and mathematical relationships to create and elucidate new knowledge, new entities and new realities. This play is a process akin to the manipulations of the shapes in a tenogram.

My final thought is this: Addressing the STEM educational challenge is at least as much about changing the way we think about learning as an innovative activity as it is about priorities and funding. If we are to be successful in improving our education system, we must better engage our full spectrum of future technologists, scholars, scientists, engineers, and entrepreneurs. In doing so, we will leverage the most distinct American trait, our creativity. Thank you.

DR. BEERING: Thank you very much, indeed.

Last but not least, Dr. Wiburg.

DR. WIBURG: I’m Karen Wiburg. I’m the of Research in the College of Education State University. I want you to know that ionately involved in STEM education for 25 specialist in schools. Even being that I’m inspired by the new math and am successful

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Associate Dean for New Mexico I’ve been pass years, a math so old, I was

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at it. I’m really talking about many projects of which I’ve been a P1 or co-PI in STEM education.

I’m honored to be here to represent New

Mexico State University, which is a Hispanic-serving research intensive university. At New Mexico State, we live and work in the laboratory of the future. The majority of our state represents much of what the nation will become in the next ten years. We have many challenges. Our students score at low levels. I think we're at the bottom in math and science. And, yet, when you analyze that data, it's a matter of addressing the achievement gap.

I have data that indicates that Anglo students scored at 75 percent, our Native-American students at 25 percent, our Hispanic students scoring 45 percent. So our issue is the achievement gap issue. The opportunities that we have in New Mexico State and the New Mexico and in our university is that we have been successful with the help of funding from NSF and from our state to actually close the achievement gap and also to increase the amount of diversity among our engineers our scientists and our mathematicians.

I want to give you some key examples, just a few, of areas where we've been successful and hopefully answer that question about whether we've done wrong before and where put our money and how do we better to .5 spend our money to improve education first.

I want to share a personal example that's very close to my heart. I'm a co-PI researcher on this project. There's a small district -- it's not to small. It's about the second or third largest district about 16,000 kids. in New Mexico on the border called the Gadston district -- Gadston Mathematics Initiative funded by the National Science Foundation.

In that district, which is one of the poorest districts in the state, last year after four years, our fourth grade students in that district who are 95 percent Hispanic, 65 percent English language, and very poor scored at or above all fourth graders in the state. How did we do it? We did it by engaging the entire school in the top-down/bottom-up effort by engaging everyone in doing math including principals, by totally supporting the district and having it all pointing in the same direction, all teachers doing the

same thing.

The Gadston model has become so successful in the state, we just recently had a Town Hall in New Mexico, and we agreed that that model was powerful so .5 that our MSP, Math Science Partnership projects, of which I'm the head of one, agreed among us from the University of Mexico, New Mexico State and Tech, that we were going to continue to work only with those schools that will partner with us so that their students come to summer academies to learn standard-based NSF-type curricula, go back to their classroom, and work with us through the entire year to go ahead and implement that kind of curriculum in the classroom.

So we believe in New Mexico that one of answers where we can get a bang for our buck is that we have to have schools commit as total schools along with a partnership with the university. And we also have mathematicians, eight research mathematicians on MSP and math educators. It has to be a total effort. It can't be every class room doing a different math program or every school doing a different math program. So that's the Gadston model.

I want to move along the pipeline, I believe, and start in elementary school all the way through graduate school and highlight just a couple of programs that NMS that are highly successful in increasing the number of minority students that are going into STEM education. The first one is the Alliance for Minority Participation. The program is funded by NSF and also by our state in 1993 with three universities where they had a total 253 minority students enrolled in science and math.

Currently there’s 580 minority students enrolled in these programs, and increase from 24 percent to 42 percent. NMSU has a most impressive record with STEM students and minorities tripling over the same period from 98 to 283 students. We also have an Alliance for Graduate Education and professorate. I don’t think we can stop until we graduate people in the professorate so they can begin training people who are going to be our future scientists and engineers.

When I became associate Dean of research for the college of education, I started an alliance and there’s about $40 million dollars in STEM outreach. I

just want to say that the key to all the success in all programs is increasing the responsible involvement of the students in doing mathematics and science and engineering in real-world problems.

And as they go through the grade levels, they’ll have more and more experience working with real scientists, mathematicians, and engineers working in laboratories, being mentored, and inquiry. Our future economic well being is dependent on an aligned effort to begin math and science as early as preschool. And we must all focus in the same direction.

This is the key for me. And what Coppen

and Hale write about, why our money hasn’t worked from the legislative initiates to the colleges to the classrooms. We’ve got to get together to get rid of these separate cultures. All have to face the same direction.

DR. BEERING: Thank you. It’s story time before we get the panel to get reactions here. It’s a story of two fathers who are concerned about their bright but unfocused sons. The younger one says, What did you do about your son? He said, Well, I’ve taken him out of

the normal school situation and hired a tutor for him who is very bright and thoughtful. And I hope I will get him to follow in my footsteps.

And the second one says, Well, maybe I can do that. This story happened 3,300 years ago, and the two fathers were Dr. Nicomachus and the king of Macedonia. And the two sons were Alexander, later to follow in his father’s footsteps and to become a scientist as well as a general and a monarch.

And the other fellow Nicomachus was his doctor whose very talented son was Aristotle, and he did not become a physician, but a philosopher and wrote in gratitude for his father’s insights a book called the Nichomachaen Ethics which is the foundation to this day of modern philosophy.

So we’ve always had this problem. Questions from the panel. Martin?

MR. BEMENT: Yes. I wanted to thank you for your testimony. First of all, let me assure you that NSF is reasserting its leadership. I don’t think we ever lost it, by we’re certainly focusing on it more and more i all the time. And clearly the guest and model is

repeated in El Paso and Appalachia and any other contexts. And the key is as you said, partnerships, community interest, especially in the business sector, and alignment with the school districts. And that S pattern is repeated over and over again.

The issue that I would like to get your views on is that at best, at best there are systemic initiatives, there are math and science partnerships. We can touch 200 school districts out of 13,000 in the nation. So we have a good generation model, a good creativity model. How do we get a good implementation and propagation model? How can we build a brush fire?

MS. WIBURG: I think one of the issues that we've done in our grants is we've asked the schools to be partners in Title 2 money and bring money from all sectors to bear. And that's a matter of building that kind of alliance. We have a couple of master's of arts in teaching mathematics and science, one's with the Smythe Science Academy, and we're developing courses.

It's a matter of getting all resourceses to agree that we need to move in this direction. And our districts are happy to pay us to work with them to

develop a master's of arts programs for their teachers and their districts, and they're happy to pay for that out of titles.

DR. HEPPERT: I think another issue is that as we move to the point where science is assessed in the same way that literacy and mathematics is currently assessed as part of NCLB, there will be some rude shocks initially in the results of that. And there will be districts as a result who will be searching for answers to these questions.

I think the work that many NSF programs have done and the models that have been developed through many NSF programs stand to be models that can then be adopted by those districts to really -- in an effort to improve their student achievement.

So I think the fact that we’re about to move into -- assuming things go as planned -- to move into a more high-stakes era in science testing, actually stands to help improve implementation of existing models that have been developed through NSF support.

DR. BEERING: Warren?

DR. WASHINGTON: I have a question.

Obviously the National Science Foundation and other groups have funded many programs that have been proven to be successful in various states. And I’m always wondering why after we’ve carried out this research in scientific education, why it doesn’t get accepted by other school districts even in the same state. Can you offer some opinions about that?

DR. BARNETT: I think in general they don’t know about it sometimes. I just came back from a meeting with some educators in South Dakota. And one of the things I noted is they don’t try to make one program fit all. They have schools that are in their -- I wouldn’t even call them cities because they don’t have real cities. They have towns. And they have rural areas -

And they don’t try these programs to those two types way because they won’t work. They laboratories that go off to some of schools and bring programs to them, other techniques of that sort.

But what I was trying to get at is I think to address bringing of schools in the same have mobile truck these more isolated and they do have

there are scientists in near virtually all school districts. And if we could find ways the reach out to them, we could find a way to get them involved with the schools. And they will -- they’re not the ones who are going approve education by themselves, but they can stimulate people and make them aware of other programs.

MS. WIBURG: I think we need to be very careful that we have a balance allowing people do to their own thing and have some kind of state level recollection. I know that New Mexico is -- everybody envies us because we’re really so small that all of us know each other. I know people in Brigham Young, and we’ve all worked together in New Mexico and Utah.

And so we’re trying at the state level to set a state stage in which we all embrace the need for improving math and science. And the way in which math and science becomes important is reading. No one says, Kid don’t have to do reading. So we need to change that to a state level. So we have to have some big picture, some kind of set of principles that can drive everybody. And then we have to allow for differences in adapting these models. But all of the models have to have high

standards for kids.

DR. SULLIVAN: My question is a variation in a sense on Dr. Washington’s question. It is an enigma how successful models where they originated within work sponsored by the foundation or work undertaken by professional associations or school districts how you get the word out so you have a little more -- little less successive reinventing of the wheel with just enough minor variations that it can’t possibly mount on the same axle. I may be a little more building on prior successes.

Do you have any suggestions for the foundation or the board in terms of questions to pursue on how we might help the communities be more aware of what the science foundation’s data says about successful practices and working research environments that still need to be brought to bear on these problems?

DR. HEPPERT: Partnership, partnership, partnership. I think one of the things that has always appealed to me about NSF-funded programs is the degree to which they emphasize building those kinds of relationships among scientists, engineers, mathematicians

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and education faculty among college and university professors and both teachers and, you know, science coordinators and districts among districts and regional organizations that can support and augment educational funding.

Those are incredibly important things to do. And I think even we’ve had some success with some NSF programs that essentially took the sort of peer mentoring model where, in fact, while the focus of that program was not a reasonably successful suburb and district, we helped used faculty and resources and reasonably successful suburb and districts to partner in helping -- and professional development activities with more the urban districts.

And there was benefit for both sides, frankly because the suburban districts were actively involving creating materials, actively involving to help implement materials. They benefited from being able to see what was working on the ground in the urban districts, much of which works with kids who are not struggling. It helps improve the achievement in kids who are not struggling.

Another example of that is there are faculty in our education school in Kansas who are nationally world-renowned experts in special education who develop tools and strategies for helping students who are underachievers because of functional difficulties.

The fact is that they've found that those same tools that help those kids learn better are very effective at helping kids improve their achievement who don't face any kind of learning challenges.

So I think there is an enormous wealth of experience, opportunity, and an enormous wealth of ideas about things that do work out there. And helping to bring the largest possible groups together to exploit those and to explore those is going to benefit the entire education community.

MS. WIBURG: I think we also need to recognize that there's different cultures. We have the book of lesson study -- I have a book coming out on lesson study. I can't even remember the original book. But teaching is a culture. Higher ed is a culture. We've certainly had fun trying to blend the cultures of the College of Education and the College of the

Mathematical Sciences culture. Those do not necessarily naturally understand each other.

And a great deal of work and research might have to go into what are the cultures of public, what are the cultures of higher ed. Why are these cultures so different, and how can we bridge those cultures.

DR. BEERING: I want to thank our panel, and I want to give you the answer to who those famous tutors were that I talked about a moment ago. They were Socrates and Plato respectively. Jo Anne, master teacher, you get the last word, then we're going to have a 15-minute break.

DR. VASQUEZ: I'm sorry. I had to ask about the top down and the bottom up because one of the problems that we face is not being able to engage administrators to understand that this is the way that we need to be teaching in order to move the system. We're not all so lucky to have the fine Dr. Stevenson as a key, And so how do you do that?

MS. WIBURG: And I have a handout. I brought two handouts. One was my document. I hope

somebody gave it to you because I brought -- I also have a Gadston student who ran another one. We took it totally down to where I worked closely with the institutions for many years. And she said, This is how we will do it, as well as teachers being involved in teacher-director kinds of activities.

I think we’re wasting our money if we don’t have school districts where the administrators aware of what we’re trying to do with teachers. I think it’s just so essential.

DR. VASQUEZ: Do you think that we’ve not done -- “we” being NSF programs, all of us collectively in the community -- have not done a good job of going to the administrators’ associations and helping them understand the way that we’re going to make this nation move?

DR. WIBIJRG: I think it’s a whole different culture. I think they do what’s useful and what’s practical. A higher ed does what’s research-based and those are two different worlds. And I know I wrote an article with the superintendent and talked about how do you bridge these two worlds because I think they’re so very different. And we haven’t done a good job. I’m sort of a collaborative researcher in the university and public school, but I don’t think we speak the same language:

DR. BEERING: Thank you all very much. We’ll get back at 3:15.

(A break was taken from 2:55 p.m. to 3:19 p.m.)

DR. BEERING: We are obviously all having fun. I want to reiterate how gratifying it is to see you all here and to have read your submissions that you mailed to us beforehand. And I’m delighted to welcome back Shirley Malcom, an alumnae of the National Science Board; and my good friend and colleague, Leon Lederman; and Judy Opert Sandler for this particular panel. And let’s start with Shirley Malcom.

DR. MALCOM: Thank you very much. I want to express my gratitude for this opportunity to come and speak to the National Science Board around this particular issue of whether or not we need a new commission. Maybe I should start off by answering the

questions. Yes, we do, and, yes, there’s a lot to be done.

I want to thank the previous panel for making it unnecessary for me to use at least the first third of my presentation. Therefore, I will have an opportunity to focus in on some of the other things that maybe have not been said.

But I do want to do some sound bites with regard to the last panel. Thank you, Karen, for making the point that you can get very high performance out of students that everybody has written off. Thank you for making the point that we have a lot of knowledge about what works, but not enough; that we need to do more of what works and stop doing the things that don’t work; that we need to -- that we have underinvested in research needed to answer questions about what works for whom under what circumstances; that we need action research -- research into practice as well as research into policy; that we need to focus on the educational continuum K through 21 -- pre-K through 21, because quite frankly all of our chickens do, in fact, come home to roost.

ii The challenges around teacher education

have to be owned by higher education. You can’t pass that off to somebody else’s problems, and that means that the math and science faculty have to figure out how to perform partnerships with the education faculty in order to address the teacher-quality issues.

Thanks for saying that science and science engineers have a role in terms of interacting meaningfully and collegiately with practicing teachers to form a community of learning and for saying that there can be, in fact, constructive engagement between the science and education communities with educational agencies at state, local, and federal levels; because I think this needs to be underscored. There are things that we can do if we choose to be engaged.

How can there be -- how do we form -- how do we focus, that is, on implementation as a serious area of research and practice? Because I think this is where we have really fallen down with regard to a lot of the things that we know. We know that there's a role for technical assistance, for capacity building, and for intermediaries. But the experiments are just not being done to determine what design principals apply across all

of those different circumstances and context.

At the end of the day, we have to learn to provide to the many from a shifting demographic the kind of high-level subject matter contents necessary for America's future. That's the bottom line. And I think the question is how do we get to that bottom line? One of the issues is we should have to stop looking for magic bullets. They are not out there. And we also can't boil the ocean. That's not constructive.

But somewhere in between that continuum we have got to focus on -- the Commission needs to focus on what can be done constructively in a systemic way, not a piece over here and a piece over there. Yes, we need to focus on teachers; yes, we need to focus on the way that schools are organized for high performance or not, and to that, I would say necessary but not sufficient. You’ve got to look at how the pieces get put together.

And we have to learn to use the talent of all of our students including those we have traditionally written off or that have traditionally underparticipated in science and engineering fields: women, minorities, and persons with disabilities. We need to invest in

strategies that accomplish this end.

I have been drawn to Professor Lederman’s interest basically because it makes sense, but also because it has been shown that when it is implemented it does work for all students. NSF has invested in programs over the years to carry out its broadening participation mandate that it has under the Science and Engineering Equal Opportunities Act; that is to do all that it can to promote participation by women, minorities and persons with disabilities.

When targeted programs for these groups were challenged because of concern of their constitutionality, the Foundation jointly modified its investment strategies to focus on the support of institutions as well as whole systems. Programs such as Advance, which focus on women; the AMP program that you have heard about in previous testimony; the Alliance for Graduate Education into Professorship. These programs are making a difference.

The recent challenge to the NSF bridges program at Southern Illinois University, Carbondale and I the subsequent capitulation by the university demonstrate

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the tenuousness of such efforts on the ground where they are needed and even where they are effective. The issues here revolve around the way that programs are implemented.

The Foundation is going to have to look at the question of implementation and whether it has responsibilities in terms of the need to provide technical assistance for the programs that it has tried to put in place. Is it enough to simply pass grants on to universities and hope that they do the right thing or that they do things right? I don’t think that we can afford this when we, in fact, need these programs in order to see to the goals that the Foundation has.

NSF needs to acknowledge that it has a facilitation role as well as a role in supporting research and education. I would urge that the Commission look at all of its work through the lens of broadening of participation. Will this work advance access and quality? And unless the Commission does, we won’t realize our goals of producing a 21st Century STEM education.

i Thank you.

MR. BEERING: Thank you very much, Shirley.

Judy Sandler.

MS. SANDLER: Thank you. Good afternoon and thank you for the opportunity to join you today. I am Judith Olpert-Sandler, vice president at Educational Development Center in Newton, Massachusetts. And much of what I will say has clearly been said by prior panelists, but I think it will be good reiteration.

You have my written testimony, so I will use my time to highlight one concern that has continued to trouble my colleagues and me in our 20 years of working in urban and rural school districts across this country. The United States continues to ignore elementary science education. Because of No Child Left Behind with its initial emphasis on literacy and mathematics, science has virtually been eliminated from the elementary school day especially in communities with high rates of poverty and underrepresented students. This trent must end.

Yet in a question-and-answer online last week sponsored by the White House, Secretary Spellings

was asked if there would be funding for elementary science. Her response pointed to a new math initiative because a strong math base would help prepare students for challenging high school science courses. Yes, a strong math foundation is, of course, important, but not sufficient for a learning progression in science. I was disappointed that she also didn’t recognize the need to support a strong science base.

To succeed on a secondary level and beyond all students need a solid foundation of science beginning at the elementary level. Inquiry-based experiential science at the elementary level requires students to use math, literacy and reasoning skills in an authentic-applied context. And at the elementary level, we shape students’ attitudes and interests in a way that inspires them to pursue further study or careers in science. And for many students that I am most interested in, they only get their science if it’s through the public education system.

So while we are refocusing the national spotlight on precollege STEM education as we have just seen in the President’s State of the Union address and

the emerging details in the American Competitiveness Initiative, I am particularly concerned that science education now more than ever deserves increased attention at the elementary level.

If the goal of the United States is to ensure that scientists and engineers emerge from the educational pipeline to improve both its competitiveness and the global economy and promote future innovation, then it must remember that the pipeline begins in elementary school. How we address improving elementary science education is a complex endeavor that touches on many systemic challenges. Ultimately we must influence the decisions about how teaching and learning are made in more than 65,000 elementary schools.

Educators across the country need our urgent support and our best guidance now. And when it comes to decisions about science education, it is imperative that the National Science Foundation be the driving force in championing the best models, practices, strategies and research. To do this we must leverage funds, more than was just proposed in the 2007 NSF budget. NSF must become the national beacon of

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leadership for science education at the federal, national, state, and district levels.

To do this, NSF must take the following steps: Under NSF’s oversight and support, scientists, together with science educators, need to continue the development and implementation of innovative and scientifically accurate curriculum materials and ensure that they get them to the schools.

NSF has supported the development of high-quality professional development resources for teachers and administrators and must continue to do so in order to address the overwhelming number of elementary teachers without science background and the support they require in their schools. NSF must continue to Support the development of models for teacher education so future elementary teachers will be better prepared than their predecessors.

Research regarding assessment and how it relates to learning has traditionally been fostered by NSF and must be continued. As the states meet the 2007 science testing requirements of NCLB, we need to guarantee that state and district leaders have the best

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assessment models at their disposal in the requisite support around them using them effectively. The accountability consequences are too big to get this wrong.

Finally, we need a better body of research on programs, policies, and strategies in addition to the expanding research on teaching and learning. We need research that is informed by the knowledge and practice on the ground, and we need research that is translated into effective action.

NSF should be at the forefront on research on scaling up and sustaining effective practices. The most difficult challenge for all of us is to ensure that the most effective practices reach the school leaders and influence their decision making. Such a challenge cannot rely solely on our political leaders or the science and business communities. Therefore the NSB commission must include in its charge a focus on implementing high-quality elementary science programs.

The implementation must be signaled by seating practitioners on the commission. Such a move will ensure critical buy-in from educated groups outside of the science disciplines, such as teachers unions and administrators in school board associations. I believe this is the only way we can ensure the next generation of scientists, science educators and science literate citizens. Thank you.

DR. BEERING: Thank you very much. Leon?

DR. LEDERMAN: Thank you. I’m not sure I want to thank this committee for getting me here. I lost a lot of sleep and so on, and I’m worried. Let me just remind all of you that I learned -- I went to school when we dipped pens in inkwells and memorized the times table. And when it came to 13 times 14, we used something called the slide rule, which was two wooden sticks that you rubbed together and it gave you the answer.

And then something happened and things were good. I thought -- I remember all the way through high school having splendid teachers, extremely well educated and inspiring and classes of kids that talked to each other and profited enormously from supper teaching.

My written remarks -- which I’m going to skip over since Shirley brought them up, but I do want to point out that it’s a good example of an egregious and inexplicable fact that our science curriculum nowadays in this great nation come right out of the 19th century and that essentially 95 percent of all schools introduce the first exposure to a science curriculum as biology.

Well, if you look at a biology •book and skim through it, you will -- I’m sure all of you, even the quasi-professional biologist will find dozens of words you’ve never seen before in eight syllables or more which kids have to memorize and forget as soon as the exam is over. Why is that so? Why are we still teaching curriculum that came out of the 19th century?

That’s a good question. I don’t really know the answer to it. I’m working hard to try to understand that. And we know from so much evidence that I don’t want to review that things are not going well for the nation in science education and probably other things, and so we ought to blame somebody. Who are the culprits? There must be culprits here somewhere. There must somebody who is guilty of this.

Well, in a way. If we look at the universities -- and there’s where I take some blame. I

spent many, many years as a professor at Columbia

University of Chicago. They haven't been helpful. Many of your colleagues, Mr. Chairman, in the university presidents' offices don't lose much sleep about K-12 education. A few do, and that is wonderful, but not enough. And there's many, many other places -- Congress, of course. Maybe the founding fathers. Maybe education should not have been left totally as a local option. And that's something clearly you're going to have to face in some sense in making some changes.

The scale is awesome. You know, if we have a national crisis -- if the Chinese and the Indians are going to eat our lunch -- that is a Chinese lunch, I guess -- if all this threatens the status of our nation as scientific and industrial power, both our economy and our culture, we should have a major status.

And if you look at all the efforts -- in fact, I read a report of the Commission, and I thought this report is wonderful. It's exactly right. Everything they said was correct. And then I noticed it was the 1983 report. So you have an easy problem. Just change the title and multiply all numbers by about six or

seven, and you've got your report done because there's nothing I saw in there that wasn't relevant to our problems today.

But it’s a major problem, and that’s why I’m very hesitant to accept all the statements about, you know, how we go about it unless I feel confident that the Commission -- the wisdom of the Commission that you found has to look at this -- and this is a physicist talking to you -- has a major system that needs to be looked at critically. And doing more of this and doing more of that and raising this budget and raising the other budget I’m not sure is enough.

And, therefore, the scale has to be such that we can think of this -- I always think of this as a war. Wars are well known. We know how to do wars, and we know that a war is an increment of $50 or $100 billion a year. This is a war on ignorance, on scientific ignorance and just the illiteracy of the major functions -- major parts of our society on what science and mathematics and engineering really does.

So I think we need to look at this in a I very global way and think through imaginatively and creatively how are we going to make a change so that somebody, you know, ten years from now doesn't look at your report in 2006 and say, My goodness, nothing has changed? Because that's what we can say about all previous reports. I think there is a consensus. We are still a nation at risk.

Let me make some comments now. I don't want to belabor the notion of rearranging the curriculum. That's something I have been working on and probably have convinced upwards of 1,000 high schools to do physics in ninth grade. And where we have data, it's not enough. It seems to be a positive influence on the learning of science, I think.

But let me also do something in a part in a disagreement with many of my colleagues about the whole issue of science education as opposed to education. I happen to believe that science is a humanistic activity. It's a liberal art. And I think it would be dangerous to advance the notion of science education over and above other educational activities. And I understand the logic of getting salaries up by virtue of competition, but I would certainly like to see all teachers' salaries to go way up. I think that's the way we're going to get better teachers, and that's a comment I want to make.

But let me carry this particular idea out. I believe that science literacy, which I think we need for the general public, requires a strong element in the teaching of science of process, and that doesn't happen. If you go to science classes in the high school, you teach physics and chemistry and biology. And nobody talks about how science works; when does it work; when doesn't it work; what can it do; what it can't do.

It's a universal culture. It is carried out by human beings with a mixture of curiosity and skepticism, with ego and humility, with rigor and risk, and with a sense of both adventure and a need for salvation in a frightening 21st century.

And I think this becomes extremely important in particular because among the students who will take these courses, which will be required, I hope, of all students in our revised K-through-12 science curriculum, there will be the people who are more likely to change the way science education is done than by the scientists or the future scientists or teachers, and they

will be legislators who are all liberal art students.

If we can influence the science literacy of the future legislators and Congress and the White House and throughout the state levels and so on, we will do a lot more, I think, for the future of both scientific research and for the future of science that I can think of.

Another thing I want to say a few words about is the recruiting. I hear a lot about professional development, and I hear a lot about raising salaries. think that’s extremely important. We don’t recruit well. We don’t get the best students on the campus to go into teaching. If you ask a parent, What do you think about teaching? Oh, we want best teachers for our kids. Well, would you like your child to be a teacher? No.

Teachers have lost social status. We’ve

got to think about that in addition to economic status. We have got to make teachers so respective, the best kids in the campus going to college will be attracted to teaching. That is something that I think is very important.

And then you have the problem of

retention. All of us know idealistic young people who don’t care about the salary -- I want to teach because teaching children will improve their life, and that’s what I want to do. And they last, what, three years, four years, five years as superb teachers and the system wipes them out. So you have to address that system -- that complex system.

Again, you might need physicists to help you because they are good at systems, but you have the teachers and the unions and the principals and the parents and the school boards and the legislators and the book publishers -- all of these different entities that have the power and the authority in the educational system. And that’s something you have to look at and think about and try to do something creatively about.

It is a tall order, but this is a powerful group, and so you should be able to look at those components and then again keep asking the question: Why is it that we haven’t succeeded? And there may be some things in what I say and things I didn’t say or forgot to say which are relevant to an imaginative, creative approach to a problem and try to be different and keep

saying to yourself, Why can’t we use the 1983 report? It’s perfect. It’s even grammatically okay. I checked it.

Thank you.

DR. BEERING: Well, thank you very much in deed, all three of you.

Questions for the panel? Warren?

DR. WASHINGTON: As you recall, we had some sizemic event such as Sputnik, there was a big change in attitude -- public attitude as well as the Congress and the President stepping forward to be aggressive in trying to improve science and engineering education in all levels of education. So what will it take to get that sort of national momentum?

DR. MALCOM: You mean short of having somebody launch something? I think that the biggest problem is that we haven’t gone to the places and had conversations with the public in ways to explain what the issues are. I mean, we’ve probably -- the people in this room own Tom Friedman’s book, but it’s not clear to me that the people who are out in other places do that.

I think that we’ve got to begin a

conversation in communities and in community-based groups and in churches and in other places where we aren’t necessarily -- we haven’t necessarily been comfortable going and having this kind of conversation, but talking about it in terms of what does it mean for people as individuals and what does it mean for their communities, the fact that we are sending good jobs some place else.

I mean, it was fine when we were able to send the jobs where they were dependent on cheap labor, but now we are basically sending the jobs where they're not -- where there are high-end jobs. And I think that it is the demand -- building a demand for change that we have not done the tough work of doing that.

But we began by a statement from the top political leaders, but how long is that going to stay in place? Can they -- are those conversations going to be sustained for a sufficient amount of time to be able to reach the hinter lands and reach people throughout the nation?

DR. SANDLER: I think you also have to bring in more of the administrator networks and associations that run the school districts. Because we

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can't just think about the curriculum -- creating new curriculum as you're talking about and making it more innovative. There is really good programs out there. But when it comes to getting them into schools, they don’t get into the school districts.

I think you have to reach out not only to teachers who have -- we’ve spent a lot of time trying to bring teachers along, but we have not spent enough time bringing along the school boards and the school administrators so that they can understand that science is a core subject, and that it’s just as important as every other subject in the schools.

I also think you have to have more partnerships with the Department of Education. The money that comes from the Department of Education goes to the states, the states to the local districts. They need guidance and more partnership on the kinds of programs that we want to see in our schools. I work both with the NSF and with the Department of Education. And it’s very different the way we look at how decisions are made at the school level. And I would really like to see more of that collaboration.

DR. LEDERMAN: There’s also a difference -- where did we go wrong with Sputnik? Ifl some sense Sputnik was a challenge which required a total mobilization of the ability to make more scientists. And that’s what our colleagues did- They dropped everything. They dropped their slide rules and pieces of wood and they wrote books, beautiful books, Harvard Project Physics and so on -- books that the teachers couldn’t handle largely and were too hard. And they tried too hard, I think, to immediately ramp up the production of scientists.

And to me that was one of the mistakes of post-Sputnik epoch. Rather than concentrating on science as part of our culture, which doesn’t hurt you at all in recruiting future scientists, but the longer those scientists will become powerful aids and allies in producing the new kind of society.

DR. BEERING: Betsy?

DR. HOFFMAN: Well, Greg, Leon challenged me to ask scary questions at the break, so I’m going to try to ask scary questions.

I was very interested in your comments,

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Judy, on the need for emphasis on elementary education. I couldn’t agree more. I think there is -- we talk a lot about losing students in middle school. I think it’s because we lose students at the elementary grades.

And when I was provost at the University of Illinois in Chicago, the dean, Vicky Chew (phonetic) did a study of the entering math and science scores of the elementary education students and found that an alarmingly high percentage -- and I am not going to throw out a number, because I can’t remember, but it was way in excess of 50 percent of the entering students -- were in need of remedial mathematics.

And it goes back really to the fundamental core of the questions I’ve been asking all along. It’s very encouraging to know that there are lots of other reasons than compensation that students are dropping out of teaching, but there have got to be reasons why the very entering students who are going to •be the nations K-through-8 educators are deficient in mathematics before they start college. And if they’re deficient in mathematics before they start college, they are going to be phobic about math and science and they are going to

communicate that to their students.

So the scary question I ask is: What does work in that environment? It was directed to Judy to start with, but I really -- I want to hear from all three of you.

DR. SANDLER: Well, we work in developing elementary curriculum in both math and science, and we have spent a lot of time working with teachers. And I really do feel that the curriculum materials are -- there are some wonderful programs out there, but the teachers have not had the kind of background and training and support.

Now, one might also wonder about the preparation of teachers. I’m remembering some prior reports also about whether or not we think about the education of teachers as a liberal arts degree in graduate work in disciplines, or whether we also think about education of teachers as an undergraduate degree. And I think that is something that the country has to also reckon with too.

I also think that there is some merit in the question that Jo Ann asked earlier, which we’re

trying to study now, if we have schools where no science is being taught whether it’s because teachers are not prepared, do we just continue to not have science taught, or do we put science specialists in in order to stop . another generation of kids who aren’t going to get science?

So I think there are a number of ways that we start beginning to make new decisions about the teaching profession and who teaches the kids science.

DR. LEDERMAN: I just have one comment on that. You have two things going for you in primary school. YOu have kids coming in who are scientists because they ask the right questions, all kinds of questions. They are curious, interested.

And then you have this enormous curricula of materials that have poured out of the Lawrence Hall of Science and other places, these hands-on activities -- -- and CPOP and TIMS, and those things are marvelous things for engaging the students and the teacher in electroactivities which in the beginning is largely processed. How do you find out things? How do you learn things? How do you deal with the distribution of heights of students or lifetimes of soap bubbles or all kinds of things.

All of that is positive, and we had a lot of experience in the Chicago public schools teaching primary school teachers those materials. And the teachers reacted like you would expect the kids to react. If I had only known this ten years ago. And they worked. And you watched these schools, and you watched the kids start zooming up in state-wide math tests that have nothing to do with really the curriculum with the hands-on stuff, but it engaged the student. It was partly play, partly storytelling.

So I think that there’s no logical reason why that can’t -- why that situation cannot be fixed. It takes the better training of the primary school teachers. That is what you have to do.

DR. MALCOM: I want to give the scary answer, because Leon -- what Leon did is he talked about the people who are currently in the system. And I want to talk about the people that you get. The issue is I don't care how they come in. The question is: How do they go out? And what is it that you are requiring of

them as a part of the program to get to be a teacher? Are we requiring nothing? If we require nothing, we will get nothing.

So that's -- the scary answer is that higher education has to look at itself, and that state certification has to look at itself in terms of producing yet, again, people who are deficient in those areas. We know that people can come in with poor performance and be given a set of experiences that help them to raise the level of performance. But they're not going to do it if they're not required to do it.

DR. SANDLER: We don't have requirements for elementary teachers to have disciplines as their background.

DR. BEERING: Thank you. Warren?

DR. WASHINGTON: One subject that hasn’t been touched on and that is the short half-life of high-level superintendents and administrators, especially in large cities where every time there is a political change there is a new superintendent that throws out the old agenda and brings in the new. And no one seems to be around long enough for accountability to set in for any

sustainable practice or continuous learning curve to be put in place. Do you have any comments on that?

DR. SANDLER: Yes, I would like to speak about that for just a second because one of the NSF .5 studies that we did was on sustainability of science reform. We looked at ten school districts that had anywhere from 30 years to 5 years and keeping what we’ve considered their inquiry-based programs alive. And many of them had, as you know, superintendents leaving -- and we probably should bring Cindy up to talk about this.

But what we found was where there was a real belief in how you teach children, and it was well set in the teachers, that belief in how you teach did not leave regardless of bringing in changing of -- whether it would be financial concerns, or new administrators.

It’s very hard if you know that you’re supposed to teach -- that you enjoy teaching and you know your kids are learning in an inquiry-way to then be given a book where you just do rote learning. Teachers who really don’t believe that aren’t going to teach that way. And we just need to be able to support teachers and allow them to teach in the way that they know is the best way to teach kids too.

DR. LEDERMAN: My only comment is that's part of the system. And if that part of the system is crucial, then one has to think about how you can reorganize the system so that doesn't happen. That's the way you win a war.

DR. MALCOM: I have been -- we have been working at AAAS with the school system where we have gone through four superintendents, seven chief academic officers, et cetera -- I mean, there's been massive turnover over and over again, and yet we have basically been able as an intermediary to hold the reform in terms of going forward.

So let's think not only about the structures of superintendencies and what we need to do in terms of preparing new kinds of superintendencies, but what are the alternatives in terms of maintaining a stable base of reform even in the face of this kind of turnover.

I mean, yes, we wish that we could, in fact, create these wonderful people who could withstand all kinds of things that happen to them; but, in fact,

the job of superintendents are incredibly complex. They run food services; they run police departments; they run transportation systems -- think about it. They run large procurement systems. There are all of these kinds of massive people -- pieces and somewhere in the middle of that, they are supposed to hold on to the notion of being an instructional leader.

I mean, we are, in fact, putting them in an untenable position and, in many cases, in total isolation from the kinds of partnerships that they need to enjoy with higher education, with business, with community leadership, with political leadership so that they can basically withstand a lot of the kinds of pressures.

But in many cases, people leave with issues that have nothing to do with the academic performance of the students. They leave and they are not being able to be successful because of things that have to do with regard to the kind of management of the system or the failure to maintain political support; or, in fact, school boards that are got really acting in such a way in the best interest of children.

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DR. SPiNDLER: May I add one thing to that? I also want to say that where I am really worried about science now with administrators is that because of the AYP, the adequate yearly progress report, and how we are holding schools to their performance in math and reading and how superintendents are holding their schools to their performance in math and reading, that we have to be really careful about what will happen when the science testing comes in in 2007.

We need to get this right. We cannot -- first of all, I am not absolutely sure how it will be in the adequate yearly progress. I have tried to get that reading from the Department of Ed, and I am not sure if it will absolutely be part of the AYP. It is not clear yet. But if we do, then we are going to see a lot of low-performing schools, and it will be difficult to ratchet it up once we have more and more low-performing schools in the mix. So more and more you have to get to administrators to kind of give them some help in support. But they need -- really need this right now, especially under NCLB.

i DR. BEERING: Kathy?

DR. SULLIVAN: I’m interested in addition to the investments that the Foundation has made over the last decade in formal schooling and school settings in both student and professional development in other levels. There has been a sizable amount of investment in products, activities and so forth. And they are aimed at or directed through or implemented through informal settings -

Iwould be interested in hearing from each of you about what has worked, what has not worked, what have we not thought to ask, failed to include, et cetera, et cetera with respect to the Foundation’s approach to the informal settings.

DR. MALCOM: I’d like to begin that fact, have an approach to informal science I think grew out of a belief that we have time that children learn best when they n the out-of-school and the in-school by issues.

I think that informal has a lot going for it doesn’t have all of the kind of

other things, so you can experiment a

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because we, in education that held for a long are reinforced i similar kinds of it. Number one, baggage regs and

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lot. But also there is the opportunity that -- to take what is fun and what is enjoyable and then be able to look and see what kinds of effects that it has on children.

We had one program that was funded by the Natural Science Foundation, an informal education program called Kinetic City, Mission to Vearth, which was kind of clubs joined with the technology component. And we decided that what we needed to do was to augment the support for the evaluation of that particular program because we did not think that we would get support for that program in terms of the school seeing it as a legitimate out-of-school thing to do unless we were able to show them how it related to the things that counted, the average yearly progress issue.

So we could show that it made a big difference in their terms of their learning of science, but one of the things we did was we invested in the evaluation to determine whether it made any difference with regard to reading and writing. And low and behold, it did. So we were able to come in and come to a school and say, Gues~ what? Doing this sacrifices nothing in

terms of your annual yearly progress. And, as a matter of fact, we saw gains that were off scale, and it was in the levels of advanced and proficient, not below basic and basic. But we’re talking because of the use of science materials, you were gaining in areas such as inference and, you know, those kinds of things.

So I do think that there is a strong role for informal, but we need to begin to do the research and the evaluation that can help people understand that informal in enhancing and augmenting, and it is not something that takes away.

DR. SANDLER: May I add one to that? Two cautions that we’ve seen -- we do a lot of work in informal science and after school programs in museums and have developed some wonderful curriculum materials. My colleagues would say that the individuals who work in the after school programs need support and training as well. And they would also say that one of their concerns is that with the emphasis, again, on exactly what Shirley was saying, they want to make sure that informal science stays informal and that children do have the fun and play with the science and work with the science materials.

And what’s happening is the pressure is to just make it an add-on to the regular school day.

DR. BEERING: Two more quick questions, Jo Anne and then Warren.

DR. VASQUEZ: Okay. I am going to go back to a question that I asked another panel, and I noticed that Shirley illuminated this in her written testimony here about national standards. Do you think -- and I put it out to the three of you. I know that Leon has worked tirelessly and tried to change the high school curriculum. Do you think that the Commission -- if we, in deed, do form the Commission, we should perhaps focus on being able to move these standards to a direction where they may be accepted nationally and statewide and maybe locally?

And I'm not saying the type of curriculum the person uses -- that they use in a district. I am saying that we have one set of standards. Because those areas of the world where they have such high marks, they have one set of standards and unfortunately some of them have one set of curriculum. So what is your feeling in that?

DR. LEDERMAN: Well, I tend to agree. I certainly believe we need a national educational strategy to direct our 15,000 school districts. And I think it's going tobe a lot of fun to get a set of standards as a component of a national educational strategy. And standards are often so purposefully loosely drawn that I don't think it should be impossible to get consensus and agreement on one set of standards. So that all those states that have C, C-minuses rating of standards will go up and will get a B-plus set of standards.

And the standards, of course, are not driven in concrete. They can be modified. In fact, Shirley's standards at AAAS have to be modified. They are out of date now, and one has to look at them periodically.

But I agree with you completely. I do think that we need national agreed -- consensus standards that all states will be held to.

DR. MALCOM: One of the things that I think it is important to do is to make the distinction between-federal standards and national standards. We are I not talking about federal standards. We're talking about

national standards -- things that we agree to all do and hold ourselves to because they are worthy of adoption, because they are reflective of what people need to know in order to be able to be successful citizens and because

- they are, in fact, comparable to what people in other countries with whom we are comparing ourselves are, in fact, doing.

And I think that we've got to change -- we've got to change the language because the notion of federal basically raises hackles. You know, it sounds like an imposition. Although I can't imagine anything being more of an imposition than what we currently have.

DR. BEERING: Warren?

- DR. WASHINGTON: I wonder if I could ask each of the panelists if they could say something about -- in the area of science education what has worked and what has failed with respect to No Child Left Behind.

DR. SANDLER: I mean, I clearly have already said this, -but I'll -reiterate it. I felt like in the last 10 or 20 years working in elementary science that we had made some great gains. I had mostly worked in large urban school districts. And in 500 rural school

districts across the country. And I have had two large centers founded by NSF to disseminate and bring the curriculum to the school districts that were invested -- NSF investment.

- In the urban schools that I work with now, they are -- well, let me ask you this: If you were being held accountable to be tested in the reading and math in your school, you would use every minute -- every minute of the day working in those subjects because you're going to be held accountable. There is no reward for teaching another subject. There is -- you know, and where -- and especially if your children are having trouble in reading and math.

So that's for me the worse problem that has happened is that we have actually stopped teaching science. I once said to a superintendent when I would go into their schools and see that the teachers were no longer using the materials. And the superintendent said, How can they possibly do it? We just have to put it aside now. And that's really -- that is what is happening because they are under so much pressure to have their schools meet their scores, and I think if we could

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reverse that or change that -- that's why I'm so nervous about will happen. If we have really good assessments, it will be fine. If we don't, we're in trouble.

- DR. LEDERMAN: My information is anecdotal. I visit a lot of schools and I hear constantly the complaint that we're training a generation of test takers and not critical thinkers. That is something -- the standard criticism of the methods we are using now. I think one could probably alleviate that.

One of things I had somewhere here had to do with our minimum use of technology in the classroom, educational technology. I think educational technology cold maybe alleviate that intense pressure. But the whole idea that if you strike out, you're fired is just wrong for education. It's okay for baseball.

DR. MALCOM: Let me say something good about No Child Left Behind. I think that the focus on the accountability for all students has been a positive for No Child Left Behind. When we did our analysis that led to this particular report, A System of Solutions, and when we talked to the superintendents, they said that prior to that time it was okay for schools to have --

groups of students who didn't go well and the essential don't-show-up-that-day kind of a bad attitude on test day.

And so in terms of the accountability aspects of No Child Left Behind, I think that that has been marvelous. The problem is always in the details. One of the major problems is that what Judy identified, and that was that the testing has been only in mathematics and reading.

Another problem has been in that we have not had models put forward as to which things actually work to raise scores in mathematics and reading, even if they are not direct instructions in mathematics and reading. There are things -- we do have the research, for example, from North Central that tells a totally different story about the role of science. Not just science, but also in terms of mathematics and reading.

The standards? That's been a problem. Because, in fact, if each one is able to set what their standards are; and, therefore, what their assessments are likely to be, there is a lot of gaming that goes on in terms of fixing it so that you can properly meet those

particular levels and I think that the monitoring issues.

So let’s not throw out all of the aspects of this. We haven’t had the kind of focused attention on equity before No Child Left Behind. We have allowed the S systems to basically get away with educating part of the students and not all of the students. But the operational being -- operationalizing this has not worked. And I think that we have to really face up to that particular area.

DR. BEERING: I want to thank you very much for your insightful comments. We have run a little bit behind. We have one more panel of five witnesses. And I would like to ask then Ruth David, James Von Ehr, Della Williams, Robin Willner and Michael Miravalle to take a seat at the table.

May I please remind the panelists to speak directly into the microphones and also out of the corner of your eye keep your eye on Dr. Webber.

Following your presentations we are going to cut out the give-and-take with the board members because we have another 12 people who are going to make brief comments. We do want to get home before the -next

snowstorm.

So let’s start with Ruth David.

DR. DAVID: Thank you. I do appreciate the opportunity to be here this afternoon. Although I S will say being in the last session of the day, you always run the risk of everything important already having been said. I think today the problem, though, is even more serious because I’ve left with the feeling that everything important was said two decades ago.

Like one of our earlier speakers, I read the 1983 report in preparing for today and was left with a real sense of deja vu. I, too, believe that had our nation's leadership acted on the recommendations made in 1983, we might not be here today. Nonetheless here we are.

I need to offer one disclaimer. I am not a teaching professional. Ironically, I will digress for just a moment. When I graduated from high school, I intended to be. I intended to major in math in college and teach math in college. Unfortunately I encountered some of the issues that have been raised by earlier speakers today. My early college math courses were

boring. They were theoretical and disconnected from anything that was interesting to me.

Furthermore I began, at that time, to look at the relative differences in pay scales understanding that I was attending college by working my way through and getting scholarships. So these were very real issues to me. At the time physics became more interesting, and I was recruited into electrical engineering with the dangle of a full scholarship and a job. I didn't look back.

So while I understand that compensation may not drive people out of the profession, I think we need to also understand that it may drive people out before they opt in to the profession. So while dollars aren't the only issue in getting good teachers, I do believe that that is an issue that must be addressed because I think it is an indicator of the value our society places on the teaching profession. And I believe that is very important and needs to be addressed.

So my remarks today are going to come from an employer perspective. The services my company

i provides depend on the intellect of my work force. And

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the educational system of this country is in every sense the foundation of my supply chain. Now, it’s an interesting way to look at it, but the educational system in the country produces the input to my corporation. I

- cannot thrive without good inputs. That is a very, very critical point to me.

With you’re indulgence I would read just a paragraph from the executive summary of the 1983 report. “We must return to basics that the basics of the 21st century are not only reading, writing, and arithmetic. They include communication and higher problems solving skills and scientific and technological literacy, the thinking tools that allow us to understand the world around us. These knew basics are needed by all students, not just tomorrow’s scientists.”

I think that is a very, very critical point. From an employer perspective, that’s a very good description of the kind of individual I need. Yes, I need deep technical skills in some cases. But unless those individuals are able to apply those skills in a multidisciplinary context in the real world, there are of limited value in my corporation.

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I need scientists and technologists who understand how their solutions interact with everything around them. I need people who cannot only solve problems -but people who can define the problem that must be solved. I need people who can communicate clearly and compellingly to diverse audiences. I think math and science education provides a good foundation for these skills, but I think it goes beyond that.

I tend to refer to that as systems thinking. That is one of the reasons I’m a strong proponent of systems engineering, systems thinking, enterprise thinking as a basis to the critical thinking of problem solving skills that we need today.

I will end with just one final point. One of the questions that we were asked is whether a new commission could add value. I believe the answer to that is yes, but with a couple of caveats. It’s yes if it provides a road map. A road man with a clear destination but multiple paths; a road map that encourages and learns from experimentation; a road map that describes a process, not a report, that gathers dust; a road map with measurable outcomes along the way; a road maps with a

lessons-learned process imbedded that identifies those successes, and we’ve heard many today, and shares them as best practices. I think we can learn internationally as well as from our own national schools.

So I think the answer is yes, but we need more than a report. We need a call to action. We have to move beyond description of the problem and recommendations. We have to move to action and to clear recognizable progress.

Thank you.

DR. BEERING: Thank you very much.

James Von Ehr.

DR. VON EHR: Thank you for the invitation to be here today. An educated work force is vital to me as a technological entrepreneur and CEO of one of the nanotechnology startups. I have several suggestions in this oral testimony and a lot more to say in my written testimony.

Number one, we must continue to make educational opportunity available to those who care to become creative technologists. Telling success stories of technological leadership is really important. Kids that give up a promising technology career to become lawyers might reconsider if they heard more about successes like Google, or they were exposed to successful and inspirational technologists.

I personally donated millions of dollars to universities and expect to donate millions more to provide opportunity to those who want it. I want to help those who want to help themselves.

Two, we should continue to call attention to attention to the declining enrollments in technology but should not be surprised if our calls are unheeded. Economist Joseph Schumpeter's creative destruction applies to nations as well as industries and more ambitious countries will enrich the world as they rise, even if we allow our relatively lead to fall.

Schumpeter's basic point was that the success of capitalization naturally leads to complacency, stasis and socialism. But human ingenuity and creativity figures out a new way of doing things that sweeps away the old, starting a new cycle and revitalizing capitalism.

Our past success is understandably led to

complacency. If parents don't push their kids to invest in their future, well-meaning people in the government can't do it for them. Improvement starts with good parenting, not a concerned government.

Three, if we want our industries to continue to be successful in the world markets, and I think that is incredibly important, we should allow them to import the talent they need or support them in moving R&D to where the talent lives.

The alternative is to hand competitive advantage to foreign industry. Good business people will not willingly sit around wringing their hands about declining enrollments and won't hire less than the best because of any national origins test. If I can't hire the talent here, I will hire it wherever else in the world I find it. If I am restricted from doing that, I'll probably just retire and consume instead of investing and creating.

Four, recent immigrants more often push their kids to excel than do comfortably, successful U.S.-born families. We should remember our roots as an immigration-friendly place and be more welcoming to

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foreign brain power. We are still a very desirable country, and instead of training technologists here and forcing them to go home due to Visa issues, we should welcome them to stay and contribute. They would help our economy and might provide some good role models for the benefits of investing in the future and working hard.

Five, I’d like to see more experimentation in schools to see if we could find a way to not turn off the natural curiosity of kids while we educate them. Competition is a good thing for business. It is a good thing for nature, and it would be a good thing for schools if we would try it.

Abusiness that is starved in successful products and lavished money on its failures wouldn’t last long. A free market in education just might develop some schools that would turn kids on to learning. Unfortunately the trend in education now is toward top-down control and making everything that is not forbidden mandatory.

More top-dog for schools and more spending will not solve our problems. We need to get some fresh minds thinking about these issues. We need to give them the freedom to innovate without too much nitpicking. need to measure them by results, not be review -boards evaluating their processes.

- And if you think I am just grumpy, look at math and science compared to the rest

are a long way from the top even though

themselves very highly.

Now I tell people that I when I was born in America. My parents class, but my dad always pushed me to go hard, and get a good job working with my our future generations the opportunity to education. We don't owe them a good life want to work for it.

Let's offer the opportunity for our kids to be leaders of the technological future. Let's encourage them to seize that opportunity. If they choose not to do so, we don't solve that problem by wailing and gnashing our teeth. We should look to the free market and educational competition to find alternatives because the world is a competitive place, and it won't sit by while we introspect.

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our test scores in of the world. We our students rate

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So I thank you for your attention and certainly wish the best for the success of this board.

DR. BEERING: Thank you very much.

- Della Williams.

DR. WILLIAMS: Thank you for the opportunity to speak with you today. I am speaking as the owner of Williams Pyro, a high-tech company in Fort Worth, Texas. We manufacture over 200 products, all of which were designed in house. And we conduct research in wireless communication, smart sensing, RFID, data fusion, and artificial intelligence algorithms.

In reviewing the testimony of other speakers, I read some wonderful ideas regarding training of our teachers, reshuffling our priorities and ~engaging science and math professionals as well as community leaders and parents -- engaging parents.

Often the most challenging task is the most beneficial. And it is no different with science and~ math education. The National Science Board can more easily reshuffle priorities, increase teacher training, and increase spending. But these efforts alone will not make a difference.

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Our national graduation rates and achievement scores are flat. While spending on education has more than doubled over the last 30 years, even adjustin~ for inflation, more money hasn’t helped our children. I’ll be honest, the National Science Board will have a much harder time engaging parents nationwide in their children’s early education. But parental involvement especially early in a child’s education is vital.

I think we are missing the boat on K through 16. I think education should start at the three-year-old level. And by “education” I mean informal teaching by parents and guardians as well as age-property preschool. Let me give you an example.

My three-year-old granddaughter loves to go exploring with me on my land. A few months ago she picked up a piece of lava rock and asked me what it was. This led to an entire afternoon of learning. I shared what I knew about volcanos and lava, and then we locked up volcanos in an old set of encyclopedias. She was fascinated by the pictures and the exciting origin of the rock that she held in her hands. When her parents picked

her up the next afternoon she told them what she had learned, remembering the knew word lava and volcano and explaining that basic concepts. They were amazed.

- Young children have minds like sponges,

S and the time to start educating them is when they begin to start asking why. Those of you with children and grandchildren are familiar with this age around. Three years old children begin asking why about everything. Tragically this is when many parents begin tuning out.

I can’t tell you how sad I was when I heard a recent radio commercial promoting in-car televisions as a way to stop your children’s whines. Every question is an opportunity to teach children when they are so thirsty to learn. But this early education can only start if we educate parents as well.

Over the last two weeks I interviewed AP students and AP teachers in math and science classes at our local public high schools. I asked students who had the greatest influence in their life and education, and they named parents first and then their teachers. Our students with an interest in advanced math and science were largely encouraged by their parents.

Another interesting thing that many of these students told me is that math started making sense to them in the fourth grade. Similarly the AP academic coordinator at the most prestigious public school in

S Forth Worth said that the best age to start emphasizing math and science was kindergarten. With a hard-core emphasis starting at the fourth grade. This should be encouraging news because as President Bush pointed out in his resent education speeches, U.S. students test competitively in the fourth grade. It is in junior high that we start to lose them.

President Bush’s physical 2007 budget includes $380 million for education, much of that going to train teachers and draw math and science professionals into the classroom. To ensure that these efforts succeed, that our children succeed in math and science, we must supplement the children’s proposed efforts with parental involvement, and we must do it early in a child’s education.

As the President pointed out in a recent speech at 3M, we have an international need for people with math and science skills. And if our children don’t

have the skills to compete, those jobs won’t go away; they’ll just go to another country.

Thank you.

DR. BEERING: Thank you, in deed. You

S spoke to me in my grandparent capacity.

Michael Miravalle.

DR. MIRAVALLE: I would like to thank the Board for my opportunity to come here. I greatly appreciate it. I have been passionate about this for about the last ten years.

In my written testimony I provide a list of programs that my company has with various public education organizations around our area ranging from junior colleges, high schools, middle schools, and now we are pushing down into the elementary school. Which, coincidentally, we didn’t know we were doing it, but we happened to be hitting these transition points -- bringing kids in at the elementary school level before they enter middle school, and then at middle school before they go to high school, and then when they graduate high school before they go to college to get

, them interested in technology and science.

I won’t go over those programs at this point. What I would like to say is those programs seem to match with what I have heard today from everyone on the educational side in terms of how to augment or to assist public education from an industrial standpoint, from an industry standpoint. So it seems to me in reading the -- also reading the reports going back to 1983 that we’ve had a 23-year hiatus on, forming a partnership with industry, because that’s mentioned in all of the reports, and I noticed it was mentioned in quite a bit of the testimony.

But we seem to have no national strategy. And, to me, a strategy is formed based on some objectives, and we don’t seem to have objectives on how to engage probably the most powerful ally education has in this country which is its industrial base, the SNT base. I think that I have seen numerous companies around the country who want to participate or do participate, but it is in a very individualized way with no focus. So I would intrigue the National Science Foundation, who I think are in a particularly unique position to work with both industry and academia to define a set of objectives

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on how we can nationally engage the SNT base in this country to work with public education.

I have -- I also work with the university systems,-and that seems to work fairly well. And, of course, we're all familiar with the spin-off successes of companies that are spun out of universities. And so I think that that really is not where the focus should be, although that's been emphasized over the years. I think having partnerships all the way down to the elementary school level, particularly in the disadvantaged school areas, with local industry can have a great deal of impact.

I would only like to add to that, based on what both my colleagues, Dr. David and Mr. Von Ehr have said. I think as an employer, I have to have people. And as a business, I either make a decision to be profitable or go out of business. And so the clock is ticking in this country. If I can't hire skilled kids from our American education system, I'm going to hire them from somewhere else, or I'm going to fold my tent. And I don't think we want that happening around the country. So I think the clock is ticking on this, folks,

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and I think.

We really need a strategy on how we are going to pull this off. And I really think there is an opportunity for a strong partnership with industry if someone would just sit down and reach their hand out.

Thank you.

DR. BEERING: Thank you in deed.

And, finally, Robin Willner.

DR. WILLNER: Well, it is very difficult being the last speaker because so much that is so worthy has been said. I am going to answer some of the questions that have come up over the last several panels, if I may.

I'm vice president of the global community relations at the IBM corporation, and I very much appreciate the invitation today and the opportunity to share with you some of our experience and, in particular, our new transition in teaching initiative.

Just over a year ago, IBM's chairman and CEO Sam Palmisano cochaired the national innovation initiative. Their report articulated the competitive challenges that are facing the United States and the urgent need to, and I quote, Unleash America’s innovation capacity to drive productivity, standard of living, and leadership in global markets.

The question came up earlier about why the public and parents don’t see the urgency that is clearly recited in the NIl report and that you have heard today, and I would encourage you to reach out to business as your partner in explaining that urgency and beginning the national debate he need to have. I think you heard from four of my colleagues in business today with such eloquence talking about the issue. We can make this a public understanding.

Clearly if we’re going to be prepared for an innovation economy and if the United States is going to succeed, human capital is the critical element. I want to quote again from the NIl report, All Americans will need a variety of tools to be successful. People are not born with the inherent innovation skills, but they can learn them. They can acquire the social skills to work in diverse disciplinary teams and learn adaptability in leadership. They can develop communication skills to describe their innovations. They

can learn to be comfortable with ambiguity to recognize new patterns with data, to be quizzical and analytical. They can learn to translate challenges into opportunities and understand how to complete solutions from a range of resources.

That’s a very tall order. We heard earlier many of our panelists reference the importance of problem-based learning, of inquiry-based learning. As we begin to set standards for science education, it cannot be the road acquisition of a lot of knowledge and information about science. It has to be the multidisciplinary skills I just described. Problem-based learning and inquiry-based learning is not only a key to engaging students, it is exactly what they are going to need in industry. It’s the way industry works today. So I encourage you to include that.

This is a tall order, and it requires terrific teachers. There’s no other way around it. At IBM we decided to take on this challenge with our greatest asset, IBMers, and that is when we launched Transition to Teaching in September. This comes on the heels of dozens of other programs. I’d love to talk to

you about them, but I know our time is limited.

But in Transition to Teaching what we are doing is encouraging our IBMers to consider second careers as teachers, not only to consider them but we will provide them the support and financial incentives they need. We are providing

$15,000 to participants for tuition reimbursement and for stipends, we are providing online mentoring, we are providing peer support, and we’re encouraging them to take a leave of absence, maintain their benefits, receive a stipend and take up to four months for student-teacher or practice teaching in a real K-l2 environment.

Again, as everybody else did, I looked at and I think the Transition to Teaching programmatic essentials that the Board identified at that point and that do, and we still need to move much areas.

First of all, teachers must have a strong in-depth background in the subject area. That’s a given. We should be finished with that debate about whether or not science teachers need to know science. We’re the 1983 report, really meets the National Science we still need to further in these

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focusing on IBMers who already have a bachelor's degree in math or science discipline. We also believe that IBMers need to learn the craft and the practice of teaching; however.

It's not enough to be terrific in math, science or engineering. This is very important. None of us would want our children to be taught by someone who is volunteering an hour a day from their real job to come in and teach math or science, and that's why we are encouraging all of our participants to spend up to four months in a real K-12 environment.

Again in your 1983 report there was a recommendation that secondary school mathematics and science teachers should have a full major in college and math and science -- and then two other points: a limited number of effective education courses and practice teaching under qualified teachers.

I'd like to say that those two things are so woefully missing from most of our teacher-training programs. We are working very closely with -partners in New York and North Carolina that in deed focus on a limited number of effective education courses. We are

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bringing experienced IBMers with full careers into the classroom. They have to be respected, but they really need to learn their craft. Not through a 45-credit education program, but through a consensus on what is a limited but effective number of education courses.

They also need to do their practice teaching under qualified teachers. That needs to be a worthwhile experience. IBM's transition to teaching is but one small effort. We are beginning with 100 participants. And even if we double that number, we will not make an appreciable difference in a teacher shortage in national proportions. Though we are convinced that our participants will have a significant positive impact on the thousands of students they will teach over the years.

Even if we double or triple our programs, and even if tens of other companies -- dozens of other companies, the private sector cannot solve this problem alone. We can influence and improve teacher preparation programs. We can enhance the reputation of teaching as an option for math and science professionals, and we can jump start this national discussion with influencers like

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the National Science Board, school districts, colleges of education and others.

I wish we had more time this afternoon, but I hope that we can begin that conversation and work

closely with you and all of the sectors that were represented today to begin to solve this problem. Thank you.

DR. BEERING: Thank you very much. I wish we had started with this panel because you framed the issues magnificently. I would like to respond by telling you that in the medical schools and law schools of our nation, we use the case method of teaching, and that really speaks to the kinds of concerns that you have brought up.

I believe that there is time for one or two questions. I believe Betsy had the first one.

DR. HOFFMAN: Well, first of all, I want the entire National Science Board compliments IBM for its initiative, and we did send a letter to your CEO really complimenting him on this incredible initiative.

DR. WILLNER: And we appreciate that. We have sent it to all IBMers. We are very proud.

DR. HOFFMAN: I also want to say how much I agree with Ms. Williams’ comments on starting math and science education at age three. Just as we understand that you need to start elementary reading techniques and pattern recognition at age three, we’re finally coming to understand that learning a second language is easier at age three than it is at age 20. What we haven’t figured out as a country is that math is a language and science is a language that goes with mathematics. And just like foreign languages, it’s best learned at age three.

And I think that if we can get that message out through this commission process, that yes, it is schools, yes, it is better education of teachers; yes, it is better pay for teachers; yes, it is encouraging better students to enter teaching, but it is also engaging the parents in learning when their children’s minds are sponges. I just want to thank you for bringing that important point out.

DR. BEERING: Warren?

DR. WASHINGTON: Yes, I also want to commend IBM, but there are many other companies -- TI, for example -- that have really made a substantial

commitment. So learning how to get the corporate world to go through the commitment to involve an engagement I think is a major part of this study that the Commission on Education should really pay some attention to.

Because I know from talking with Diana Natalicio, who is on our board, in El Paso she’s discovered that some of the best minds in mathematics coming in to her university are coming in from Ciudad Juarez because that is where the machiadora plants are, that is where the Fortune 100 plants are from the U.S. They have a stake in the game, they’re involved in the educational system, and it’s making a huge difference. And it is on the other side of the border.

DR. BEERING: Other responses? I have a group of friends who lived in Hong Kong who sent all their children to a boarding school in England and college and graduate school in America. There’s a message there. And then they go back and make money.

If there are no other comments, I want to thank you again. Remember we have a reception following this program for all of our participants. And I’ll now turn it over to Michael for the comments from the

audience.

DR. MICHAEL CROSBY: Thank you. This is the public comment period, and just very briefly -- I will call out the names of the people who have signed up. That was our only requirement, that you sign up in advance. If you would come to the microphone -- the microphone stand here in the middle of the room. You will have five minutes to provide comments to the Board.

I'll read your name out and then come up. And then I remind you again of the presence of Dr. Webber.

Dr. Webber loves to play volleyball and I've heard he has a really mean spike, so he'll be keeping your time for you.

First speaker is Colorado State Representative, Jack Palmer.

DR. JACK PALMER: Hello. Thank you for coming to Boulder, and thank you for the Internet. That has really come in handy for all of us here. I want to talk to you a little bit of what the National Science Foundation has done for us. You probably know that we've gotten about just shy of $47 million worth of grants last

year. It's been an amazing fusion of cash to fund some of the great things that are done at this university.

First of all, it's a big part of our economy. - We have an entire landscape around here that is littered with high-tech companies that were founded in CU research centers. One of the most amazing stories is Ball Aerospace, which I love to tell this story because the guy who founded it told it to me.

He and some of his colleagues back not long after the National Science Board was founded, they were working in the physics department and they came up with a device -- they were trying to do some atmospheric tests and they came up with a device to guide one of the old rockets they used to use back then. And it worked so well that every time someone else wanted to do an experiment, the airport said, You should call CU and ask them how they guided the rocket.

So they started building these things for other people. And it got to the point where the CU administration came to them and said, This is a research facility not a manufacturing facility. If you want to i keep doing this, you ought to take it off campus. So

they did, five of them: a couple of students, a couple of professors, and the foreman of the physics department shop went and founded Ball Aerospace, which is now a half billion dollar company. But the amazing thing is Bert

- Macure (phonetic) , who was one of those five people, went on to become chairman of the company, made a lot of money.

And when he retired, he started Aventure Capital Firm. A couple of years ago, two guys who were in the business school wrote a business plan for a high-tech company. And it was such a good business plan that Aventure Capital Firm, that was formed by Bert Macure, invested in it. Today it’s one of our fastest growing companies. It’s called Roving Planet and it manages the wireless networks that you see all around the country at Starbucks and places like that.

So the science work that gets done at the University of Colorado doesn’t just have a one-time payoff, it actually creates capital that can then be used to fund the next generation of scientists. And that’s really wonderful for us, especially as we’ve been going through the budget crisis which I’m sure former President

Hoffman has already told you all about.

Incidentally, I want to thank former President Hoffman for working so hard to keep the university going through these tough times and all of you. Because without the money we got from National Science Foundation and without President Hoffman’s work to keep that money coming, we would have, I think, suffered even more as the economy turned down.

Two quick things I just wanted to say since you’re here. One of them is that what you do is great in terms of helping to prepare science teachers because that’s critical to us.

One of the grants you gave to a professor here named Dick McCray (phonetic), he used that money to start a program where students in introductory courses in the science -- applied math, astrophysics -- if they get an A in the course, the next semester they’re invited to be undergraduate teaching assistants. And they get paid $10 an hour with money from the National Science Foundation grant.

Once they’re done with that, they get

I invited back for another semester, but only if start

taking courses through the education department. The idea is, these are students who are probably not going to become physics majors who go into physics, but they’re good at it. This diverts them into teaching science. A lot of them said they’d never thought about it. It has doubled the number of science majors we have who are going on to become teachers.

And that’s really a wonderful thing for us because we try to meet the requirements of the No Child Left Behind Act. Thank you guys very much. I’m glad you came out here, and I hope you take some time to look around.

DR. CROSBY: City of Boulder Councilman Andy Schultheiss. And I apologize for murdering people’s name.

MR. SCHULTHEISS: He must have some European blood in him. My name is Andy Schultheiss. I’m a member of the Boulder City Counsel. And I’m an engineer myself. I’m an electrical engineer, although I think the fact that I work for a nonprofit probably brings the median income of engineering graduates down.

But I do have that scale, and I did learn it very young.

I'm here speaking for Suzie Agetin, who is the Deputy Mayor of Boulder who was called away at the last minute. And I am reflecting her thoughts here, which is why I will be referring to this paper here quite a bit. I'm here to talk a little bit about the linkage between K through 16 education in the city of Boulder.

We're obviously a college town, and we value greatly the contributions of graduates of the University of Colorado to our economy and to our community. Actually 42 percent -- something like 42 percent of Boulder's population has an undergraduate or graduate degree. Every year we go back and forth with Fairfax, Virginia as to who has the high percentage in the county. I think currently we do have the highest percentage in the country, and we're very proud of that.

And, in fact, the job market rewards both prepared graduates with skills in technology entrepreneurship and risk-taking, graduates enter a positive business climate in Boulder where the immediate income $87,000. I point that out not because it's an impressive number but as well because Boulder also happens to have a poverty rate that's higher than the

national average.

There's a great number of people in Boulder who simply don't have the opportunity to take advantage of the income earning potential that a

technology degree of University of Colorado can bring. And it's one of the things that we, as the City Council, are greatly interested in.

The reason engineering and science graduates from CU are meeting our employees' needs and technical knowledge and methods and are as good as graduates from other public institutions on the east and west coast. In fact, we hear routinely from our regional employers that more are needed to grow our economy. Some of those regional employers, I'm sure, have been mentioned already. There's places like Ball Aerospace, IBM, Sun Microsystems, Level 3, AMGEN, and, of course, the federal labs here in Boulder and down in Golden.

Our optimism, and Suzie's optimism in particular, is tempered by the reality of shrinking state~ funding and access to financial aid resources for low income families both in the K through 12 pipeline and higher education. As we go around Boulder -- and Boulder

is normally considered a wealthy community -- but you see a lot of people here who simply don't have the opportunity to get a K through 12 -- not just finish K through 12, but go on to college. And that is really the key in America to breaking out of the cycle of poverty, whether it's because of your familiar or your immigration status or whatever it is.

So in Boulder, in particular, I want to

out what the keys are to success in our

- and education-based community here. Increasingly, going to college is to the new economy. And in Boulder, science, technology are the cornerstones of our economic I want to thank you for coming here today, and work on this issue. And I also want to advocate

point out one program we do learning centers here which school district, and they’re adults together in literacy, connecting with communities. successful program in which learn together and learn to
have. We have family are jointly operated with our working with children and critical thinking, and

It’s been an enormously children and their parents kind of solve the mysteries and figure technology
essential math, and future.

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a little bit if I can for focusing on some of these access issues with folks who don’t already have that in their future -- programmed into their future and figuring out a wait to allow them into the American dream as well.

Thank you very much, and I hope you enjoy our city.

DR. CROSBY: Thank you, and we do. Our next speaker is Ms. Joy Hakim.

MS. HAKIM: Thank you. I’m a writer, and I’ve written a series of history books that Oxford published and sold 4 million copies and are in schools around the country. And so I decided to take on science. I don’t know anything about science, so I’m coming from exactly the same place that the middle school kids are that I’m writing for.

But I’ve had absolutely wonderful response from people. Dr. Letterman gave me some help when I started. Jerry Wheeler at the MSTA has been fantastic. And there’s a man at MIT named Edwin F. Taylor. And if you haven’t read his college physics text, you’ve missed out. It’s the best there is. Edwin is reading every one of my chapters giving me are really tough time when I need it and refuses to take it any money.

I do this without anybody paying me. I hear about all these foundation grants, which would be nice, but I care. We started with this question: Why have we not improved? Why haven’t things gotten better since 1983? I have a long career before I started this, by the way, as a journalist. And I’d written for years on educational issues and I’ve again and again educational initiatives with the best of intentions and nothing really happens.

And the answer that I’m hearing is: We need better teachers. No one’s going to disagree with that. But I don’t think it’s going to happen tomorrow. It may take -- if you can do it, wonderful, but you need to do something right now. And teachers are not the only way to get information to kids; books are another. And in the worst, toughest inner city scenario, if you give children good books, some, many will learn. What do we give them? We give them textbooks. Dr. Letterman was asking for a villain. That’s it.

A few years ago the Packard Foundation led by John Hubisz who was president of the physics teachers of American or something like that, did a 100-page report

on middle school textbooks. It’s on the Web. I believe you should all read it. It’s devastating. The upshot was that they couldn’t recommend a single one. Sit down with a textbook.

We’re spending an enormous amount of our national income on these books that sell for 60, 70, whatever. They’re horrendous and their error-ridden too. You want to do something? Get information out there in a different way. Books are one way to do it. All kinds of -- yeah. And what a lot of the better schools are doing is they’re saying, We’re no-textbook schools. They’re throwing out the textbooks. But then they have nothing or they have this program. You have to have something intelligent written.

Dr. Letterman was talking about process. If you want children to understand the process of science, they need to know something about science history. We don’t teach science history at all. Walk out here -- this is a leading university -- and say, I’ve got this stack of $100 bills. Any student who can tell me who James Thorpe Maxwell is will get $100. I’m not -- we’re not going to give any except maybe to some of the

science majors.

What a wonderful story. He is a kid who played, who had -- and out of this playing came science. Teach kids those stories, and then relive the scientific

principles. Tell them about Galileo then have them do his experiences. We can do something very exciting with science. And my books, by the way, are being tested in schools, and they’re really -- they’re in a school in Denver in a Latino district where median income is

$17,000 a year. -

And the teacher -- the science teacher -- I know two science teachers in Denver who are I think are fabulous. One of them has a Ph.D., and he’s teaching middle school. He’s great. I wish we could replicate him. But the other one in this Latino no school has none of the qualifications. But she’s energetic, intelligent, and bright. So that’s where I’m coming from. Thank you.

DR. CROSBY: Thank you. The next speaker is Mr. Trip Carter.

MR. CARTER: So my name is Trip Carter. am with Raytheon Company. Thanks for having us here. I’m a working stiff in the aerospace industry. And not

to -- as a statement about my intelligence, but I am quite literally a rocket scientist and have worked on launch vehicle programs most of my career.

- I also worked as the aerospace advocate

- for Governor Owens for about a year and a half. So the issue of work force development is very near and dear to my heart and in a practical sense now as we try to fill jobs at Raytheon on and fail to do so.

The aerospace industry is about a $100-billion-a-year industry worldwide. It’s expected to double to $200 billion in the next ten years. The U.S. has about 60 percent of that market share. Here alone -- in Colorado alone there are about 38,000 jobs in aerospace. I had some slides there, but you can’t see them, and there’s not enough time to go through them. So I’m happy to provide that information in more detail to anyone who would like it.

Aerospace is really not just the Department of Defense and that Nasa anymore. It’s also commercial. And there’s some very, very exiting opportunities for commercial going forward. I look at aerospace today versus 20 years when got into the

business, the opportunities for kids and young adults to get involved in the industry and do wonderful things is more exciting than ever, and the interest couldn't be any less, frankly. There is no catalyst today like there was in this l960s with the Apollo program and those types of things to generate an interest in kids.

Engineering enrollment trends are down. Our statistics show that they're down about 10 or 15 percent. And South Korea, for example, is one country that really excels in engineering today. They have about one-sixth the population of the United States, and they graduate roughly the same number of engineers the U.S. does annually.

While the U.S. is falling behind, South Korea, China, India, other countries are only excelling. So why do we care? My business largely is national security. From a national security standpoint, we certainly care. But it's also a matter of global economic competition, and we're going to see that challenge significantly in the next 10 to 15 years.

I say the next 10 to 15 years because we at Raytheon and a lot of us in aerospace believe that the

interest in science and technology starts or stops at the age of 12, 13 -- about the age of my son sitting over here in the audience. So we truly believe that if it's a problem today, it's going to be a problem at least for the next 10 years until those seventh and eighth graders are graduating college and getting into these industries.

While the engineering enrollment has declined, demand in the industry is up nearly 100 percent. Between the years 1998 and 2008, the number of aerospace-related jobs has grown from -- or will grow from 6,000 to almost 12,000 -- I'm sorry. Did I say thousand, I meant million -- from about 6 million to 12 million.

And there is a tremendous need to fill these jobs. We believe that by 2008 there will 6 million jobs that are unfulfilled for lack of science and technology education and experience. Our dependence on technology, as we all know, is growing exponentially. And it’s a pretty scary prospect that our ability to grow or even maintain that technology infrastructure is shrinking.

That should scare all of us, not only from

the standpoint of filling jobs, but five years from now, you may go to gas pump and swipe your credit card, and that information is transferred over satellite. And if that satellite isn’t working, frankly, won’t get any gas that day. So there are a thousand different examples I could give you as to how aerospace and high technology permeates your lives. It’s a serious threat to our way of living going forward.

I visit local high schools and middle schools. And I talk to students and their teachers about opportunities in aerospace. And I find that most of them are terrified at the prospect of understanding the - technology behind their everyday lives. Teachers today, quite frankly, not all of them -- many of them are very intimidated by science and technology. And I believe it’s a big problem. To many students, especially, this really is rocket science. And frankly, we need to give our students the confidence that they can go forward into careers and really make a difference in some of these high-technology areas that they take for granted.

I’ll close by saying that there are some tremendous things that we’re doing here in Colorado in

industry with education and in partnership with education. The CU system certainly, CSU, Metrostate, DU, other schools have banned together and have banned with industry to try and solve some of these problems. But frankly, it's a drop in the bucket right now.

I'll close by saying that Raytheon has a program that we have stood. Our CEO has dedicated 2 million dollars to a program called Math Moves You. And as part of that, we did a survey. 84 percent of 13-year-old kids said they'd rather clean their room or go to the dentist or take out the trash or eat their vegetables than do math homework. And I think that's -- and at the same time, 94 percent of the students surveyed felt that math was very, very important in their lives. So I'd be happy to talk to anybody off-line about the rest of this information. Thank you.

DR. CROSBY: Is Roberta Johnson in the room? Our next speaker, please.

MS. JOHNSON: Thank you. I just have a few comments. I'm Roberta Johnson from UCAR. I work on education and outreach there, and also a scientist in the high altitude observatory. -

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A few people have commented about the importance of bringing scientists involved into the educational process to help educator particularly in K-12 become enriched with sort of state of the art science.

- And one of the issues we face in that community is the university merit process is so severely tied to publications and progress in their own research field that it becomes very hard for scientists to actually engage in a meaningful way.

And there's -- what's interesting is I've noticed that more and more scientists want to, but they feel deeply frustrated that the university system does not allowed them to do this. This is something I'm wondering if perhaps the Science Board might really find some way to encourage within the university system to get the system to change so that scientists at universities actually can engage in a meaningful way and have that recognized in their promotion process because there’s a huge community there that could really contribute. And so I would like to suggest that’s something you might put on your agenda for your commission.

The other thing, there had been a

comment -- a couple of comments about the issue a-bout society really having very poor science literacy overall. And a number of people have mentioned that as an issue and focusing some emphasis on that. And I think maybe a

- way to pursue that might be to say, Where would we be without science? How would we be living? How long would we live? Imagine what that world might look like. Some creative thinking about how to bring that out to the public in meaningful ways might be something that would get to the essence of the value of science perhaps not only through the media but also working with parents and children.

And finally, one thing that I frequently come back to -- and I think it’s been mentioned a couple of times here, but I would like to emphasize -- process is a really important thing. Kids need to learn how to do science. They need to learn how to ask questions, how to pursue answers in meaningful ways, and develop their own understanding from it. But they also need to learn content too. Learning process is not enough, and we can’t expect children to learn everything they need to know in science solely by discovering it on their own.

So we need to find a balance between that important process knowledge and the content they need to learn. And that’s all I have.

- DR. CROSBY: Thank you. Dr. Rajul Pandya, please. I apologize for mispronouncing your name.

DR. PANDYA: It was perfect. Thanks for the opportunity to speak. I work also at UCAR. I recently attended the annual meeting of the American Indian Science and Engineering Society. And at the meeting, many speakers began by apologizing to the elders in the audience for having the audacity to offer their comments. And I feel similarly humbled to be addressing the group.

The focus of what I want to say is on the notion of transformative education and how NSF might enable it. One thing I admire in the NSB strategic plan is the effort to support to most innovative and potentially transformative research, research that has the capacity to revolutionize existing fields and cause paradigm shifts.

I like the boldness of that statement, and I’d like to urge NSF to embrace a similarly bold approach

to education. I’m asking NSF to strengthen opportunities to support research and applications that can change paradigms of how students learn science in the U.S.

- The words research and applications were chosen on purpose. I know NSF is interested in the question of what they can do to facilitate scientific research results moving towards applications for the benefit of society. I think the goal in education should be analogous. The need, as we heard all day, is pressing.

And the frustration I sometimes feel is, as NSF investigator, there’s a time where you end your project and you publish your report, but you don’t see sustained classroom changes. And that’s what I’d like this commission maybe to consider focusing attention on, to finding and developing pathways by which innovative educational research can become transformative educational practice.

And there’s a number of hurdles along the way. One is that identifying transformation requires long-term study. And that’s often longer than the timescales that NSF grants. Another is that

transformation requires sustained investment, which is a little bit divergent, or can be, from the emphasis on innovation. To put it another way, to effect transformation you have to keep investing in the innovation even after it’s already been shown to be effective.

Another hurdle is that transformation is about widespread adoption, which in the context of K-12 often means working outside the NSF domain. It means working with Department of Education, as we’ve heard. It means working with classroom teachers, with school boards, with industry. How do NSF PIs and how does NSF interface with these groups?

To give you kind of an example of the challenges, I’d like to talk a little bit about my experience with the SOARS program. I think many of you got to hear about it yesterday in Rick Anthes’ talk at UCAR. SOARS grew out of recognition of the need to broaden participation in the atmospheric sciences. That’s a need shared by many sciences. It’s especially acute in the atmospheric sciences.

It’s an undergraduate to graduate

transition program in which SOARS participants -- and we call them proteges because we like that enabling characteristic of that name -- they enter the program as juniors, and we continue to work with them through their master’s degree. It’s a blend of research experience at the National Center of Atmospheric Research and other SOARS sponsors, a robust and vigorous learning community, and a strong formal mentoring program. And I think the combination’s been reasonably successful. To 2001, SOARS was awarded the Presidential award for excellence in science, engineering, and mathematics.

But when I think about the success of SOARS, a lot of it boils down to smallness. We limit SOARS to 30 students so that we can provide in depth, personal and tailored support to each student. And so in some sense, the innovation with SOARS is done, the first part of the innovation. We’re now faced with the innovations around sustaining and broadening a successful program to become transformative.

How can we take NSF’s and other agencies’ significant investment in SOARS and turn it into systemic change? Not just in the atmospheric sciences or in the

geosciences, -but in STEM? How can we make what is unique about this program commonplace in our own lab, other labs and universities? To put in another way, how can we make the innovations transformative and sustained?

I think the paradox that we face is one shared by many of these programs. The key part of the success in its early stages is smallness. And so the question becomes: How do we take that smallness and make it big? And maybe -- and this is the approach we're taking in SOARS -- it's not to try to make it big, but to try to find other people who also want to be small and work together to share our smallness.

So we've actually submitted a program to do that working with collaborators in solid Earth science. The program begins inside of our program. And when they reach a kind of critical mass, they spin off into an independent program in a different community. But this is only one approach to a really significant problem. And I heard a little bit earlier today about proposals that seek like the one Judith Opert Sandier described that seek to explore the steps to transformation and maybe build guides for other

investigators.

So to summarize I think NSF knows a lot about how to encourage innovative education research. There's lots of good examples. I think the commission might focus on two things -- and I lost the last page. So those two things were -- it's what I think the gentleman from the ACS described: equating the educational mission and the research mission, realizing the two are equal, and that the transformative nature that that key focus on transforming apply to both. And the second is: looking for these pathways by which innovation can become transformative by being sustained by being leverage. Thank you very much.

DR. CROSBY: Dr. Karl Weiman.

AN UNIDENTIFIED SPEAKER: Dr. Weiman isn't here yet. Could we move him to the end.

DR. CROSBY: We will move him to the end. Dr. Mohan Ramamurthy. I apologize --

DR. RAMAMURTHY: No apology is needed. My name is Mohan Ramamurthy. I work with Rajul Pandya and Roberta Johnson at the University Corporation for Atmospheric Research. I also direct the Unidata program

at UCAR, which is a NSF-funded program. -Before joining Unidata, I was a professor in the Atmospheric Sciences Department at the University of Illinois for 16 years.

- I thank the National Science Board for the opportunity to provide input at this hearing, and I really applaud your efforts and commitment to strengthen science education in this country. Unidata’s mission is to provide data, tools, and community leadership for enhanced Earth-system science education and research.

We are a diverse community of 160 colleges and universities vested in the common goal of sharing meteorological data and software to access, manage, analyze, and visualize that data. Prior to the inception of Unidata, those capabilities were available only to a handful of leading research universities in this country. Therefore, I cannot every overstate the democratizing effects and transformative effects of technology and access to data on atmospheric science education.

According to our 2002 survey, thousands of faculty and tens of thousands of students use data and tools provided by Unidata in their courses each semester. A significant number of those universities have students

pursuing a career in teaching as well. Through their outreach efforts, several university -programs are also impacting K-12 education in their respective communities by applying weather and climate data provided by Unidata

S to study a range of Earth and environmental science problems.

Outreach efforts at the College of DuPage and Florida State University are two illustrative examples of how Unidata empowers its member institutions to advanced science education. The College of DuPage online weather lab, for example, which is named Next Generation Weather Lab, averages nearly 60 million hits a month and serves 17 million products. And amongst its larger user base, a number of K-12 students, teachers, and school district people are their users.

For the past 13 years, Florida Explores a Florida State University outreach program, has become one of the premier university directorate K-l2 programs in the world. Many Florida Explores have won high honors in local and national forums. Students who are graduates of the Explores program now enter universities as highly motivated individuals well versed in the scientific

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method.

We can make significant strides in advancing Earth science education by incorporating new teaching -techniques, active learning strategies, information technology, and integrating real-world and space science data into our curriculum. It’s imperative that we educate students by providing opportunities for general inquiry, hands-on experience, and infuse the excitement of discovery into all courses by giving students, experience in the process of science.

A critical component of science inquiry includes learning how to collect, process, analyze, and integrate data. Innovations that promote this perspective on student learning should be integrated into Earth science education but at all levels.

Earth science education is uniquely suited to drawing connections between the dynamic earth system and important societal issues and making science relevant to student. Recent catastrophic events like the 2004

Indian Ocean tsunami, Hurricane Katrina, and October 2005 earthquake in Northern Pakistan are three stark examples that drive home this point. These events also heavily

underscore the importance of multidisciplinary integration and synthesis of data from the various Earth science disciplines.

- Cyber infrastructure provided by organizations like Unidata allow students to access the very databases and tools that are used by the scientific and operational communities and provides an important pathway toward the pursuit of the long sought goal of the National Science Foundation to integrate research and education.

In this regard, I wish to stress that we must extend and enhance the cyber infrastructure at all levels, not just in high performance computing, but funding information technology infrastructure in facilities that promote active learning. To that end, we must devote resources to develop and deploy data and related services and platform-independent software that run on inexpensive desktop and departmental computer systems.

In closing, new tools and techniques provide new approaches to guide inquiry and new pathways to educate the next generation of students. The richness

of their exploration and experience depends, among other things, on the quality of the data available and the tools and technology they use. Sustained investment in science education and enabling technologies is critical

- S to this nation’s future both from an economic as well as workforce development standpoint. Thank you for the opportunity to provide this input.

DR. CROSBY: Thank you very much. The next speaker is Professor Dolores Kimbrough.

MS. KIMBROUGH: Hello. I would also like to thank you -- I’m not to speaking with microphones. I’m used to just bellowing at my students. I’d like to thank you as well for the opportunity to speak with you. I also have slides.

So I’m the principal investigator of one of the many math-science partnerships that are funded by NSF across the country. And rather than try to tell you everything that we’re trying to do, I’m going to focus on a particular feature that’s proving very effective in the professional development work that we’re doing with middle school teachers.

And I-caution you that it’s interactive so

you’re not just going to not be able to sit there. You’re going to have to participate. And so here’s the scenario. You are a seventh grader. You and your family have just moved to a new town somewhere in the United

- States. It’s your first day of school at a new school, and I am your science teacher.

(Whereupon the speaker spoke in German.)

Okay. I’m going to take 15 seconds out of my five minutes for you to turn to the person sitting next to you and tell him or her what is it we’re going to be doing in our science class today. I’m timing you. Okay. Time’s up.

(Whereupon the speaker spoke in German.)

So I’m guessing pretty much everybody in here now understands what it is we will be doing in science class today. And this is just one of our many efforts in the math science partnership where we focus our attention on English language learning with a content focus, so we’re taking it out of the realm of literacy and bringing it into the math and science classrooms. Thank you.

DR. CROSBY: Danke schoen. Guten tag,

-Fl ELD
It’s my understanding that the good Dr. Carl Weiman is here now.

DR. WEIMAN: Sorry. I’ve been off working on science education so I couldn’t get here earlier. I’m

Carl Weiman, and I’m a physicist who uses many of the same approaches that won me the Nobel Prize in physics to now look at research on how people learn science and how to improve the teaching of science at the -- particularly the undergraduate level. I’m also the chair of national academy’s board on science education. And so from this perspective, I wanted to offer some opinions on improving math and science education in this country and how the in NSF might play a more effective role in this.

Now, we’re all aware of the need to improve math and science education and the large amounts of money and effort that have been spent on this over the years with rather little effect. And the vast majority of this has been expended or focused on K-l2 education pursuantly because that’s where most of the students are.

But I’d like to argue that this is actually a mistake. And to be successful, I think that science education improvement must begin with higher education and t-hat the -- actually the -paths to improvement at that level are more straightforward than at the K-12 level.

- And I say this because we now -- there's a growing body of research that shows that the majority of college students are gaining very little useful understanding from their college science courses, that instead they're learning that science is wrote memorization of isolated facts and useless and unrelated to the world around them.

And we know that future K-12 teachers are learning this particular lesson more thoroughly than most students. My own group has done some research on this.

And if you want to find a student population that has the least expert-like views of what science is and how you learn science, don't look at the English majors or the fine arts majors. Look at the elementary education majors. We find that they are way off at the end of the scale compared to all the other student populations we've measured.

And we also find to give you some examples, that in a typical class of elementary education

majors who -- that are graduating seniors, they've completed all their math and science requirements, 30 percent of the students in that class will tell you that the continents float on the oceans. And there is --

- virtually none of them were able, when given the question: if it takes you two minutes to go a mile, how fast you're driving -- virtually none of them could answer that question.

Now, if this is the level of mastery of

math and science after 16 years of schooling, I leave it to you to decide how effective, you know, a two-week summer workshop on teaching about science is really going to be for improving their teaching. What I would argue is to make real progress, we need to start by greatly improving how we teach all students, including these future K-12 teachers, math and science in college. And I'd also plainly know how to do this.

The same research on how people learn that explains these dismal results for typical college science students is also showing us how to get much better results. And growing out of the work of cognitive scientists and education psychologists and researchers

and education in the science disciplines, we're finding approaches that are far more effective and can be readily replicated.

- And what we need now is a system of

S support and incentives to really make this the standard way we teach science across the curriculum at all colleges rather than just be anomalous experiment that it is now. And I don't really see who's going to do this, who's is going to make this happen, if the NSF doesn't. It really has, I think, a unique place to bring this about. But I don't think it's set up now to really accomplish this as effectively as it could. So thank you.

DR. CROSBY: Okay. Thank you very much. The next speaker is Ms. Jessica Wright.

MS. WRIGHT: Good evening. My name is Jessica Wright. I'm executive director of AEA Mountain States Counsel. We thank you for allowing us to be here today to provide some insight into what AEA is doing over the course of this coming year.

As you might know, AEA, or American Electronics Association, is the nation's oldest and largest high-tech trade association. We represent over 2,500 companies nationwide through 18 counsels. We also represent an international market with an office in Brussels-and an office in Beijing.

We've worked with many of you on a national level in our efforts around competitiveness. And we've been working aggressively on the Hill as well as through other national summits to address the issues that our members have deemed very critical to the success of their companies. Our support of and involvement in competitiveness issue really kicked off in early 2004 with out white paper, Losing the competitive advantage, the challenge for science and technology in the U.S.

On behalf of a direct mandate from our member companies, we have declared competitiveness one of our five focus areas for 2006. And we will be working through our 18 regional counsels to address this issue as well as on a national level.

We will encourage a renewed focus on math and science education including curriculum and educator requirements, addressing funding needs, encouraging our youth to see the opportunities in math and science and

more. R&D investment including a focus on R&D tax credits, encouragement for funding for national labs and programs within NSF and NREL and others, and high skills visa reform.

In closing, we are planning several regional competitiveness summits. And we hope we can continue to build on many of the successes that have occurred over this past year and benefit the programs that will make a significant impact to addressing the concerns our industry is facing.

And Bill Archie would not allow me to get out of here without promising the support of not only our organization but our member companies to the efforts that the National Science Board is looking into as well as other groups that are concerned about this issue. Thank you.

DR. CROSBY: The next speaker is JJ O’Brien.

MR. O’BRIEN: I too thank you for the opportunity to speak. And, Dr. Webber, since most of what I wanted to say today has already been said, you can go ahead and relax. I will he brief -- mercifully brief. How is that?

I'm a project manager with Washington Group International. We're an engineering construction management solutions company with a long history of successful projects in the United States. And our legacy is made up of very successful companies such as Morris and Knutsen, Raytheon Engineers and Constructors, Westinghouse Electric Company. So I too am a working stiff.

And what we've noticed is that we're very excited about the future. There are an overwhelming amount of indicators about the need for engineering construction in the future. If you look at what happened recently in Davos, Switzerland with the world economic forum, we were present there when Bill Gates presented to the world that the United States was no longer the IQ supplier.

It takes -- I think you're here because of that. You're aware of that, and we're trying to correct that. We look at what's happening in Asia with India and China graduating over five times as many engineers today

that we are. We're very concerned about this future as well. We know that education is the keystone for our success as an industry and for the industry in the United States. We're very motivated to help, so we're here in one respect because I wanted to hear what people were saying and what's going on, and how we might be able to contribute.

We look at some of the major concerns to date. In addition to the dwindling talent pool, you must recognize the fact that the baby boomers are starting to exit the workforce, so we must transition that knowledge that we have today to some of the future engineers. What's that future engineer going to look like? What's that future engineer going to need to be successful? We had sat down in some of our strategic planning to decide: What do we need to do to help better prepare the graduates coming in.

We know about intern programs and we're very active in that and some co-op programs. But also we think that the educational system needs to provide us as input a better product when it comes to not just analytical and technical skills, because that's

necessary, but personal skills, interpersonal skills, communication skills, soft skills, emotional intelligence skills that are often overlooked when we're trying to get people through a program in four years.

I know that's a hard thing to say, that maybe you want to extend the program because nobody wants to be in an undergraduate degree longer than four years. But some of those skills could be honed by working in teams. Those are some suggestions. They need to be creative and innovative thinkers. They have to work as multicultural teams, multidiverse teams.

An engineer of the future has to be able to incorporate new technology at a pace than we've ever experienced before. So I applaud the National Science Board for asking for our input. That's really all I have to say. I appreciate this opportunity. Thank you.

DR. CROSBY: Thank you very much. The next speaker is John Caheer (phonetic) -

MR. CAHEER: Thanks very much for affording me a chance comment. I'm a professor meritus of meteorology at Penn State University, and I was also vice provost and Dean there for undergraduate education

for about ten years or so.

And much of what I've been hearing today resonates very strongly with me because people have been talking about some things that we tried to do very hard there, and that is to convert our undergraduate program in the direction of much more active and collaborative learning. And we had very good results wherever we were able to afford that. We were able to graduate many hundreds of students ever year who actually did research as part of their undergraduate experience.

And if you look at that population, you frequently find that they -- you get some very, very good results with respect to retention of underrepresented students, of students who sometimes had some lack of direction and they got involved in the research and their performance improved dramatically.

One of the things that I did notice and I may not -- I certainly don’t have a really good sample for this. But I read many, many applications for prestigious scholarships hundreds of them over the years. And the population that we are quite interested in -- that is very talented students that don’t go in to

science and engineering, when I looked at their transcripts, I often noticed frequently noticed that they took no since or math in college.

Now, these are very good students in most cases. They’d be the kind you like to have in science. And, of course, you all know, there has been worked done right here in Colorado that shows that a lot of good students leave engineering and science. So I was quite interested in that.

Now, you would say, How could that be true? Well, it’s an unintended side effect of a very good program and that is the AP program. Most of the better students come to universities with 20, 30 credits of AP. And typically, if they’re not in the sciences, they use the AP courses to satisfy those requirements. So they’re not getting the exposure to the wonderful science professors that are at those universities at all.

So I would be hopeful that Foundation and the Board would be able to take some steps. I think they could be quite modest steps. We have a wonderful program, the Research Experience for Undergraduates, which is very, very successful in engaging undergraduates

into science.

And I would be hopeful that since the nature of research has changed so much and is changing and it’s not necessarily narrow topics but topics that involve ethical, economic, and environmental issues as well as engineering and science issues, that some of those really good students from the other disciplines who are not getting any exposure to our science and engineering professors might be invited to participate in program like REU.

And anything else we could do to engage them I think would not only recruit some students into science, but it would also -- it would make teaching science and engineering more fun. Thanks very much.

DR. CROSBY: Thank you, sir. The next s.peaker is John Graham.

MR. GRAHAM: Hello. A my name is John

Graham. I’m an undergraduate student here at CU. I feel a little underqualified with all the scientists. But I feel like I’m the kind of people that you’re trying to think, so I think it might be good to hear from someone like me.

I wanted to talk about the way that math, especially in high schools in America and early college courses, have been taught to me so far. And that is, as Carl Weirnan said, it’s basically all rule-based and it’s all wrote-based. Essentially, I never had interest in math before I reached a certain point in my math career or before I took certain courses I was required to take. Because the way that all teachers in high school had taught it was it was completely rule-based.

Like derivatives, I believe that a vast majority of math students in low levels of undergraduate and in high levels of undergraduate think of derivatives as simply the rule of taking the exponent and moving it down and subtracting. They have no idea of what’s really going on.

And I had one question of four divided by three divided by two and why that’s -- why four divided by three is not the same as four-thirds divided by two, and particularly how it’s different. This is a very simple question. But I went to a surprising amount of TAs before I found an answer that satisfactory, that squared what I was thinking. When I went to talk to my

fellow undergraduates, they had no idea even how to approach the question because it was outside of symbols.

Math has an incredibly powerful symbol

set. In fact, you don’t need to know any math to be able to run very high function mathematics because you can learn the language of the symbols. The problem with that is it’s very effective at teaching students, and that’s why we do it to high school. You can get people doing things really quickly. The problem is it’s really boring.

I never liked math. I hated math until a year and a half ago when I understood the intuition of math. And now I feel like it’s truly a beautiful thing to me. I feel look a lot of math and engineering students even now, a lot of them are involved in math for other reasons than the love of how beautiful this thing is. I think one of the reasons is how they’re taught.

And I know that Fineman, the great physicist, didn’t know how to do algebra because he couldn’t do the rules. He wasn’t interested in memorizing the rules. He just wanted to understand the intuition. So I just -- I guess I never thought about

this, but I just what Carl Weiman just said. My teachers didn’t know. That’s why they taught me that way. They didn’t understand, and that’s a big problem.

But I feel like if in high school I was taught in a way that was intuitive and complete and whole and based on understanding the complete derivation of everything I was doing and how it worked, I would have learned to love math a lot sooner. And others student that might have been lost would have learned to love math a lot, sooner.

DR. CROSBY: We have two “maybes” on the list. Let’s see if our “maybes” are here. Jessie Cadel (phonetic)

MR. CADEL: Yes, I’m Jessie Cadel. I retired after 30 years in elementary ed. This morning I had a fantastic experience in science. I judged third and fourth grade science projects at Eisenhower Elementary School. And I might add that science is healthy at Eisenhower School here in Boulder and Bear Creek Elementary where my grandchildren go to school, and Southern Hills.

And I think this coming month, we're going

to have some people come in here from the various schools, I think the advanced scientists at the university here, do the judging. Some of them were saying they thought some of the kids on the lower levels were producing some results that may be the equivalent to some of the graduate or college students were doing it. In Boulder, science is doing well.

A couple of weeks ago I heard Carl talk about developing candescence. And this gives the Greeks a problem because candescence doesn't necessarily fit into any of those categories in which the Greeks are trying to teach us. With you, if they'd listen to us when I was in the NIKE Guided Traded Missile Training Battalion, they wouldn't let them launch that instead of the Navy failures, then we could have beat that dear old Russian missile going in into.

And so I think that as listening especially the last couple of words here I was listening for "thinking," the word "thinking." I think I heard from Shirley Malcolm about the importance of thinking. Leon about the thinking processes. Ruth David, especially, thinking skills. And I could go on with some

others with implications of thinking processes.

And I think if we were to re-examine what Charles Sanders first wrote in his 1898 first lectures at the Prinpeton conference, I think that we could maybe re-evaluate what was said at that time. His suggestion

of the significance of the science approach to problem solving was identified, the significance of psychology and its implications of the aspects of thinking would be maybe relevant today.

And I was attending a class here, an advanced class, on educational psychology. And when I tried to answer -- and that would be very appropriate for the philosophy of the education class I was taking, I got. frowned down. So I think that there has been almost an unrecognized warfare between philosophy and psychology.

And I think if we were to look at the attributes of philosophy which seems to be arenas of the physical, mental, emotional, and sometimes spiritual attributes as pragmatics. And then we also look at the psychology domains in which I think they usually refer as mental, psychomotor -- psychomotor is usually first, as we know, in early education and a motive. These are

domain.

And if we could synthesize these attributes together, we could have teachers that could tell us the difference a belief, an opinion, possibilities, probabilities, beliefs, facts, concepts, inferences, and idea. And if we could have people in the classroom who could recognize these attributes with the teachers as we ask question, that perhaps we would have these -- and I talked to a bunch of schoolteachers. I said, If we don’t do our job in elementary school, we’re not going to have a chance.

And I might add for you ladies who maybe happen to be sexist feminists, when I was taking a class with Dr. Dell at Emporia State -- I’ll get her last name in just a minute -- she claimed to introduce science in the elementary school with problem solving, of all things, about weather. Adele Seller was her name. I think it would be worth remembering that elementary science was introduced by a woman. She was a scholar who studied under John Dewey.

And so I think this perhaps covered -- and when I was in Jefferson County, I’d like to add, one of the best science classes I ever attended after Carl’s -- his is one of the best and I’ve heard a lot of science since I majored in elementary science and math with three degrees. . But anyway, we had Frank Oppenheimer. He was a recluse because I think of political problems he had at the time.

He was living in Jefferson County, working on his ranch. I approached him and asked him if he’d come to our sixth grade -- I was the sixth grade coordinator for the elementary teachers in Jeffco -- and asked if he’d come in and present information about science to our sixth grade teachers. And he said he thought that perhaps drawing examples of the atom in our textbooks we were using would maybe not be very appropriate.

However, later on he did student teaching so he could teach, of all things a Ph.D. helping out with the development of the atomic bomb. But anyhow, I attended one of his classes on the inverse proportion of light that he was teaching to the science teachers. I think one of the best classes that I have ever attended.

And so I think -- I mentioned the word

“think.” I whenever we have people incorporating the attributes of the cognition of psychology with the pragmatics of philosophy, integrate these together, they should be reflective, harmonic, and integrative and be structurally sound and end up with conclusions that are supportable, give evidence of accuracy, and support especially they’re in an idea that can be supported by predictions. Thank you very much.

DR. CROSBY: Thank you very much. Our next speaker and final speaker in this public session is Sarah Rice, if she’s still here.

MS. RICE: Hello to the Board. Thank you for taking my comment. My “maybe” became a “yes” when I realized I could use the Web cast as a way of also getting lab work done over in Fermalia (phonetic) today.

So thank you to whoever put the Web cast together.

I’m a fifth year graduate student here at University of Colorado. I study evolutionary biology. I’d like to thank the NSF for supporting my graduate work through research fellowships and grants that they make directly available to graduate students, and also for supporting my current fellowship which stems from an

interdisciplinary GK-12 educational grant to a group of faculty at CU.

As a former high school teacher, this fellowship has allowed me to bring my new expertise in evolutionary biology full circle to a seventh grade classroom and to various science educators. The fellowship experience has also opened my eyes to what I think is a largely unrecognized problem in life science education. While we are all very familiar to core challenges to the teaching of evolution, there is little documentation of the effect of this controversy on what teachers teach or don’t teach.

I was serendipitously placed this year in a classroom whose teacher has self-censored her teaching of evolution for her entire 11-year career. She skipped the evolution chapter in the book and did not use the words “evolution” or “Darwin” with her students in the past. Further discussions I’ve had with teachers lead me to think that this self-censorship is widespread across the United States.

As a happy ending to this initial portion of my comments, I’m pleased to report that my teacher has

now taken on the challenge of tackling her fears this year, and we are currently co-teaching a unit on evolution. So change is possible with teacher support.

With that as context, I’d like to note a couple of bigger ideas. The National Science Boards in 1999 publication preparing our children notes that teachers are not graduating with content knowledge they need to be confident in teaching science.

It also notes that’s while state standards are admirable, teachers need help one by one in implementing those standards in the classroom, classroom by classroom.

In today’s discussion which I saw by Web cast all three of the K-12 educators and administrators on their panel as well as Dr. Lederman mentioned a large need in the area of inquiry education for students.

Furthermore, they noted we can only make this need through significant professional and science inquiry as well as science content for teachers.

So how does this relate to my experiences with evolution education? I see the controversy over teaching evolution as leading to an epidemic of teacher

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self-censorship, but really this issue is only symptomatic of a larger one which is the general misunderstanding and distrust of science that exists and appears to be growing in the public today.

One crucial way to address this larger issue is to improve our teaching of what science is, which is otherwise referred to in education as the nature of science.

Educational research has shown that students do not pick up on the essential understanding of what constitutes scientific process, observation, hypothesis, laws, and theories through implicit inquiry activities. Only through explicit instructions do kids really get that when they’re doing an inquiry lab, they are actually doing what sciences do.

This was brought home to me when I asked a fellow graduate student what the difference is between a theory, a scientific theory and a scientific law. He said he really had to look it up on Wikopedia to really be sure of his answer.

So we need to teach about the nature of science explicitly. However, to my knowledge, only one

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short publication from the National Academy of Sciences exists which provides teachers with this type of curriculum. Also awareness of nature of sciences glow amongst teachers. I myself first heard of this topic in the year 2000 as a master’s candidate in education. And the teacher I’m working with this year had never taught a nature of science lesson before this year.

So while nature of science standards are common place, teachers need help in learning why they are important and how to implement them for students.

While these concepts may seem to be boring and abstract, the existing curricula that is out there really is very fun for students as my seventh graders would attest to. So this I see as an area where the NSF Board could very productively encourage initiatives at all levels K through 16.

So when students have a foundation for understanding the nature of science, their ability to critically evaluate publicly controversial and hereon distinguishing publicly controversial from scientifically controversial topics such as Evolution and Anthropogenic Climate Change, their abilities is dramatically improved.

FIELD

However, additional teacher support is needed to prevent self-censorship for the teaching of those topics. Not only do science teachers need good content training in these topics. They also need training in how to handle potential conflicts in the classroom that can stem from these topics.

The teachers that I have interacted with through this fellowship almost uniformly cite that they had to first overcome their fear of the controversy over evolution before they could effectively learn to teach the content.

A review of the educational research literature on this topic showed me that we collectively have little baseline data on the activities and experiences of teachers in teaching evolution. And, therefore, we also have little to offer teachers by way of help.

The NSF has proven capability to enable

partnerships between academia and K through 12 education. And I think the greatest promise lies in these partnerships for addressing these publicly controversial problems. But academics are typically reluctant to

engage in such debates.

A review of is web sites of departments of ecology and evolutionary biology including my own revealed that only one, University of Michigan, is publicizing such work on their Web site.

I highly commend the NSF board for their current initiatives on K through 12 education and I urge the board to consider specific initiatives from the teaching of the nature of science and supporting the involvement of academia in the training of teachers in teaching publicly controversial topics such as evolution and anthropogenic climate change. Thank you.

DR. MICHAEL CROSBY: Thank you very much and thanks to all the individuals who provided their perspectives to the board during this public comment period. And Dr. Beering, the floor is yours again.

DR. BEERING: Thank you very much, Michael. Thank you -- each of you for coming and for bringing us your insights. A week ago we watched -- 140 million of us or so watched the Super Bowl. I thought it was interesting commentary on what turns us on. And it’s true this weekend again. We are going to be watching the

international Olympics in Torino.

And it is easy for humanity to get turned onto playing games. And we love to imagine that we could do that, and that we’re there. The question now is: Do we still have that sense of childish wonder? Do we possess the curiosity that it takes to turn ourselves on and play games or to pretend? Are we able to ask important questions, not take things for granted?

Are we willing to set our own sensibilities aside and appreciate what the other person is doing, whether that’s an international person or person of a different gender or race or religion? Are we willing to standby and live the kind of miserable existence that we see in the television soap operas every day or in the news casts we see every day? Are we willing to ask more important questions than that?

Every time I travel to another city, I turn on the news. And I am amazed that none of the things that are featured in the first ten minutes or so of the broadcast mean anything to me. It’s mayhem and it’s accidents and it’s local things that are of no lasting value. Are we willing to turn that around? Are

we willing to instill that in our educational system early on?

And I like very much what our grandmother

said about the three-year-old and the question: Why?

Are we willing to address that issue of letting our kids learn why? And I appreciate Ms. Kimbrough’s German lesson that we had a moment ago.

I grew up in three languages myself and went to a Montessori School where we learned by doing things, by having projects. We did not have textbooks. And I was amazed that the textbooks that we are using in our school system today. And I first really got turned off by them when I worked on the school board, and I was asked to help approve the text for American History in that particular school system. It was in the southern part of this country. And the books were turned down if they did not state that the south won the war between the states. Unbelievable. And I resigned from the school board as a result of that particular experience.

But I want to thank you for being open-minded and perceptive and having thrilling thoughts about the life that we lead today. We are going to have another such hearing on the 9th of March in California. And then we’re going to sit down and evaluate what we have heard from all of these many testimonials and go on with the job of revisiting the 1983 report.

And as has been so eloquently stated, We identified that problems then. We identified the solutions then. But now is the time to form a plan of action and get on with the show. Thank you very much indeed.

DR. CROSBY: And a final word for all of the Board members and the invited panelists at this session today. The provost of the University of Colorado, Boulder campus, Dr. Susan Avery invites you all to a reception right down the hall, I believe, in the Aspen room.

(The meeting was herein adjourned at 6:15 p.m.)

REPORTER’S CERTIFICATE

I, WENDY EVANGELISTA, Registered Professional

Reporter within Colorado, appointed to take this board meeting do hereby certify that the board meeting was taken by me at the time, date, and place herein before set forth; transcribed by me; that it was then reduced to typewritten form; and that the foregoing is a true transcript of the board meeting.

IN WITNESS WHEREOF, I affix my Notarial Seal this day of _____ __________—, 2006.

_____
WENDY EVANGELISTA
Registered Professional Reporter
and Notary Public

My Commission Expires August 12, 2008

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