BROADENING PARTICIPATION IN STEM

HEARING

BEFORE THE

SUBCOMMITTEE ON RESEARCH AND SCIENCE EDUCATION

COMMITTEE ON SCIENCE AND TECHNOLOGY

HOUSE OF REPRESENTATIVES

ONE HUNDRED ELEVENTH CONGRESS

SECOND SESSION

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March 16, 2010

BROADENING PARTICIPATION IN STEM

TUESDAY, MARCH 16, 2010

House of Representatives,
Subcommittee on Research and Science Education
Committee on Science and Technology
Washington, DC.

The Subcommittee met, pursuant to call, at 10:00 a.m., in Room 2318 of the Rayburn House Office Building, Hon. Daniel Lipinski [Chairman of the Subcommittee] presiding.

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COMMITTEE ON SCIENCE AND TECHNOLOGY

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WASHINGTON, DC 20515–6301
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http://science.house.gov

Hearing on

Broadening Participation in STEM

March 16, 2010
10:00 a.m. – 12:00 p.m.
2318 Rayburn House Office Building

Witness List

Dr. Shirley M. Malcom
Head of the Directorate for Education and Human Resources Programs
American Association for the Advancement of Science

Dr. Alicia C. Dowd
Associate Professor of Higher Education
Co-Director of the Center for Urban Education
University of Southern California

Dr. Keivan Stassun
Associate Professor of Physics & Astronomy
Co-Director of the Fisk-Vanderbilt Masters-to-PhD Bridge Program
Vanderbilt University

Dr. David Yarlott
President of Little Big Horn College
Chair of the Board of Directors for the American Indian Higher Education Consortium

Ms. Elaine Craft
Director of the South Carolina Advanced Technological Education
National Resource Center
Florence-Darlington Technical College

HEARING CHARTER

U.S. HOUSE OF REPRESENTATIVES
COMMITTEE ON SCIENCE AND TECHNOLOGY
SUBCOMMITTEE ON RESEARCH AND SCIENCE EDUCATION

Broadening Participation in STEM

TUESDAY, MARCH 16, 2010
10:00 A.M.–12:00 P.M.
2318 RAYBURN HOUSE OFFICE BUILDING

1. Purpose

On Tuesday, March 16, the Subcommittee on Research and Science Education of the House Committee on Science and Technology will hold a hearing to examine institutional and cultural barriers to broadening the participation of students pursuing degrees in science, technology, engineering, and mathematics (STEM), efforts to overcome these barriers at both mainstream and minority serving institutions, and the role that Federal agencies can play in supporting these efforts.

2. Witnesses:

- **Dr. Shirley M. Malcom,** Head of the Directorate for Education and Human Resources Programs, American Association for the Advancement of Science
- **Dr. Alicia C. Dowd,** Associate Professor of Higher Education, University of Southern California and Co-Director of the Center for Urban Education
- **Dr. Keivan Stassun,** Associate Professor of Physics & Astronomy, Vanderbilt University, and the Co-Director of the Fisk-Vanderbilt Masters-to-Ph.D. Bridge Program
- **Dr. David Yarlott,** President of Little Big Horn College, and Chair of the Board of Directors for the American Indian Higher Education Consortium
- **Ms. Elaine Craft,** Director of the South Carolina Advanced Technological Education National Resource Center, Florence Darlington Technical College

3. Overarching Questions:

- What is the current status of underrepresented groups in science and engineering? How do these data vary by discipline and type of institution? What role do different types of institutions, such as minority serving institutions and institutions that primarily serve undergraduates, play in broadening participation?
- What are the greatest challenges to achieving more diversity in science and engineering? How do challenges vary by type of institution and demographic subgroup? Are there policies, programs or activities with demonstrated effectiveness in increasing the participation, recruitment, and degree attainment of underrepresented groups in STEM?
- What role can the Federal Government play in addressing challenges and barriers to broadening participation in STEM? How are programs at NSF in particular helping to broaden participation in STEM, and how do those programs need to be changed, if at all? How can existing programs and institutions best leverage each other's expertise and experience toward a common goal of increasing diversity in STEM?

4. Background

According to a recent report by the National Science Board, *Science and Engineering Indicators 20101,*[1] undergraduate enrollment in higher education has risen steadily from 14.5 million in 1993 to 18.7 million in 2006, with increases projected to reach 20.1 million in 2017. In conjunction with increased enrollment, the number of science, technology, engineering, and mathematics (STEM) bachelor's degrees has also risen to nearly 486,000, and for the last 15 years STEM degrees have accounted

[1] *http://www.nsf.gov/statistics/seindl0/start.htm*

for one-third of all bachelor's degrees awarded. The composition of individuals earning bachelor's degrees in STEM has changed over time. Since 2000, women have earned more than half of all STEM bachelor's degrees, but this percentage varies widely among fields with women being disproportionately underrepresented in physics, computer science, and engineering. The number of minorities receiving bachelor's degrees in STEM has also grown slightly, with black students earning eight percent of all degrees in 2007, Hispanic students earning eight percent, and Native Americans earning 0.7 percent, up from seven percent, six percent and 0.5 percent in 1995, respectively.

Despite these gains, concern remains over the number of minority students earning STEM degrees. The proportion of STEM bachelor's degrees earned by minority students (17 percent) is much lower than the representation of minorities within the U.S. population (37 percent). Also, the fraction of the college age population, ages 18–24, represented by minorities is expected to grow to 55 percent in 2050, heightening concerns that the current gap may continue to widen. At the same time, the need for a background in STEM is becoming increasingly more important, with the Bureau of Labor Statistics projecting that STEM occupations will grow by 21.4 percent between 2006 and 2016, compared to the projected growth in all other occupations of just 10.4 percent. Furthermore, as students progress past the undergraduate level in their academic careers, the gap among ethnic groups becomes more evident with just 11 percent of STEM doctoral degrees awarded to underrepresented minorities. Trends also indicate that there have been marginal increases in the participation of underrepresented minorities at the faculty level. In 2007, within the top 100 research universities, just four percent of the faculty members in biology were underrepresented minorities, with computer science, physics, and civil engineering having minority representation of three percent, three percent, and six percent, respectively.[2] In light of shifting demographics and the growing importance of STEM, many companies and experts believe we must further the development of this untapped talent pool, as we will be relying on them to make future discoveries and innovations as well as to fill the skilled workforce.

Many experts have also asserted that broadening the participation of underrepresented minorities in STEM holds the added benefit of creating a diverse learning environment for all STEM students. Research has demonstrated that a diversity of viewpoints and backgrounds increases creativity, and a leads to a stronger, more productive workforce overall.

The Role of NSF

In 1980, Congress passed the Science and Engineering Equal Opportunities Act, which called on the National Science Foundation (NSF) "to promote scientific and engineering literacy and the full use of the human resources of the Nation in science and engineering." NSF has taken this charge seriously, incorporating broadening participation related goals throughout its strategic plan. For fiscal year (FY) 2011, NSF has requested $788 million for programs and activities with either a specific focus or an emphasis on broadening the participation of underrepresented groups and/or the types of institutions engaged in STEM education and research.

NSF's broadening participation programs are supported primarily through the Education and Human Resources (EHR) Directorate. The types of activities supported by EHR include: improving research capabilities at minority-serving institutions; developing effective recruitment and retention strategies for underrepresented groups; improving the transition of students across educational junctions; research to understand and address gender-based differences in STEM education and workforce participation; and direct financial support for underrepresented students. In addition to the broader activities supported by EHR, NSF's research directorates support programs and activities targeted toward specific disciplines. For example, the Directorate for Computer & Information Science & Engineering has a program specifically for broadening participation in computing; the number of undergraduate degrees earned in computer science has been declining over the last few years and historically the field has not been pursued by underrepresented minorities or women.

Of particular note in the EHR budget is the proposed restructuring of programs to broaden participation in. STEM at the undergraduate level. NSF is proposing a new comprehensive broadening participation program that builds on three existing programs: Historically Black Colleges and Universities Undergraduate Program

[2] Nelson, Donna. 2007. A National Analysis of Minorities in Science and Engineering Faculties at Research Universities. *http://chem.ou.edu/~djn/diversity/Faculty_Tables_FY07/FinalReport07.html*

(HBCU–UP), Louis Stokes Alliances for Minority Participation (LSAMP) and Tribal Colleges Undergraduate Program (TCUP), and newly invites proposals from Hispanic Serving Institutions, citing the mandate in Sec. 7033 of the *COMPETES Act.* Funding for this newly consolidated program would be $103 million in FY 2011, a $13 million or 14.4 percent increase from the total FY 2010 funding for HBCU–UP, LSAMP and TCUP.

During the March 10 Subcommittee hearing[3] on NSF's FY 2011 budget request, the NSF Director, Dr. Arden Bement, provided a more detailed description of NSF's vision for the consolidated program. Dr. Bement stated that the goal of the program was to build on the successes and lessons learned from the targeted programs, and to put the combined program in the position to grow not only within NSF, but to create opportunities to leverage the program and its activities across Federal agencies and with the private sector. Four potential funding tracks within the comprehensive program were also outlined. Specifically, the program would include: 1) Louis Stokes Model Alliances: this track would be based on the current program and would establish inter-institutional networks, including at least two minority-serving institutions, for the sharing of information and the development of curriculum; 2) Transformational Initiatives: this track would focus on building capacity and the integration of research and education with an emphasis on activity-based learning and educational transition points; 3) Targeted Initiatives: this track recognizes the differences between institution types as well as cultural differences among underrepresented groups, and would support focused efforts that address those specific needs; and 4) Research: this track would complement the other tracks and support research on specific barriers and issues, but would also address grand challenges in broadening participation.

The Role of Other Agencies

Other Federal science and engineering agencies such as NOAA, NASA, and DOE also support programs designed in whole or in part to increase the number individuals from underrepresented groups entering STEM fields. The types of activities supported by these agencies generally include building research capacity at minority-serving institutions, providing financial support to students from underrepresented groups who are pursuing STEM degrees related to the mission of the agency, and providing research and other hands-on experiences to students, including summer internships.

5. Questions for Witnesses

Dr. Shirley M. Malcom

1. What is the current status of and trends for the involvement of underrepresented groups in science and engineering? How do these data vary by discipline and type of institution? What are the greatest challenges to achieving more diversity in science and engineering?
2. Please describe AAAS's efforts to increase the participation of women and underrepresented minorities in science and engineering careers, including the consulting services and legal resource materials provided to individual universities and colleges by the Center for Advancing Science & Engineering Capacity.
3. What role can the Federal Government play in addressing challenges and barriers to broadening participation in STEM? How are programs at NSF in particular helping to broaden participation in STEM, and how do those programs need to be changed, if at all? How can existing programs and institutions best leverage each other's expertise and experience toward a common goal of increasing diversity in STEM?

Dr. Alicia C. Dowd

1. Please provide an overview of your research on diversity in science, technology, engineering and mathematics {STEM). What are the greatest challenges to achieving more diversity in STEM? What are the particular challenges for increasing the participation of Hispanic students in STEM fields? Are there policies, programs or activities with demonstrated effectiveness in increasing the participation, recruitment, and degree attainment of underrepresented groups in STEM?

[3] *http://science.house.gov/publications/hearings_markups_details.aspx?newsid=2753*

2. What are the current research gaps for understanding and addressing STEM diversity? Is the current National Science Foundation (NSF) support for research in these areas adequate in terms of both the level of funding and the nature of the programs supporting such research? Do you have any recommendations for changes to NSF's existing portfolio of diversity and diversity research activities?
3. How can existing programs and institutions best leverage each other's expertise and experience toward a common goal of increasing diversity in STEM?

Dr. Keivan Stassun

1. What are the greatest challenges to achieving more diversity in science and engineering? To what extent do these challenges vary by discipline? What are the particular challenges for a major research university such as Vanderbilt?
2. Please describe the Fisk-Vanderbilt Masters to Ph.D. Bridge Program, including a description of the development of the inter-institutional partnership, how the program has changed and expanded over its history and any characteristics that you feel are central to the program's success. What do you believe are the challenges to replicating the successes of this program at other institutions, including at other major research universities?
3. What role can the Federal Government play in addressing challenges and barriers to broadening participation in STEM? How are programs at NSF in particular helping to broaden participation in STEM, and how do those programs need to be changed, if at all? How can existing programs and institutions best leverage each other's expertise and experience toward a common goal of increasing diversity in STEM?

Dr. David Yarlott

1. As Chair of the Board of Directors for the American Indian Higher Education Consortium, please describe the role of Tribal Colleges and Universities (ICUs) in broadening the participation of Native American students in STEM fields, including a description of how these institutions, and the challenges they face in implementing successful STEM programs, compare to other minority serving institutions and to mainstream institutions.
2. Please describe the STEM programs at Little Big Horn College. Are there programs or activities that have been effective at increasing recruitment and degree attainment in STEM? How is Little Big Horn College partnering with other institutions in STEM? What are some of the unique challenges Little Big Horn College faces in STEM education and are these challenges similar across TCUs?
3. What role has the NSF's Tribal Colleges and Universities Program (TCUP) played in the development of STEM degrees and programs at Little Big Horn College and at other TCUs? How has the TCUP program served your institution's needs, and how does this program need to be changed, if at all?

Ms. Elaine Craft

1. Please provide a description of your institution, its STEM programs, and the demographics of your student population and faculty. How do the demographics within your STEM programs compare to the demographics institution-wide, and to the demographics of the community you serve?
2. Does your institution have particular policies, programs and activities with demonstrated effectiveness in increasing the participation, recruitment, and degree attainment of underrepresented groups in STEM? How does your institution interact or partner with other institutions and organizations to achieve these goals? What do you believe are the greatest challenges to achieving more diversity in science and engineering?
3. What role can the Federal Government play in addressing challenges and barriers to broadening participation in STEM? How are programs at NSF in particular helping to broaden participation in STEM, and how do those programs need to be changed, if at all? How can existing programs and institutions best leverage each other's expertise and experience toward a common goal of increasing diversity in STEM?

Ms. FUDGE. [Presiding] Good morning. This hearing will now come to order.

Good morning and welcome to today's Research and Science Education Subcommittee hearing on broadening the participation of individuals from underrepresented groups in STEM fields. In the last three years, this Subcommittee has held four hearings focused specifically on the barriers to increasing the interest and participation of women in STEM. Today, we want to get a better understanding of the unique obstacles faced by individuals from different racial, cultural, and socioeconomic backgrounds, and hope to identify both common challenges and opportunities to widen the STEM pipeline. As many of you know, we are in the process of examining the state of National Science Foundation programs authorized under the 2007 *America COMPETES Act*, with the goal of strengthening the NSF's research and education missions, including programs related to broadening participation.

Science and engineering have become steadily more important not only in our daily lives, but also to the economic strength and competitiveness of the United States. We have heard many times that we, as a Nation, need to produce more scientists and engineers, as well as a more STEM-literate workforce to fill a growing number of technical jobs. But we will find it much more difficult to develop the well-trained STEM workforce we need if we continue to overlook significant portions of the talent pool. We need to do a better job of developing all of the STEM talent the Nation has to offer, especially because changing demographics mean that by the year 2050, 55 percent of the college population will be from groups that are currently minorities.

Studies show that regardless of background, one-third of all incoming freshmen plan to major in a STEM field, but the fraction of students completing STEM degrees varies widely by race. Between 32 and 38 percent of all minority students intending to pursue an undergraduate STEM degree actually get one. When you compare these numbers to the 58 percent of white students and 74 percent of Asian students who do successfully complete their undergraduate STEM degrees, it raises several concerns.

First, we need to identify and address the preparatory, cultural and institutional barriers faced by underrepresented groups. But these numbers also remind me that the attrition rates, especially in fields like computer science or engineering, are too high regardless of demographic.

I look forward to hearing from our witnesses today about what is working, what obstacles remain, where we go from here, and how the Federal Government can help. Again, I am particularly interested in any recommendations the witnesses may have about the broadening participation programs managed by the NSF. This is a particularly timely issue given the Administration's fiscal year 2011 budget, in which they propose consolidating many of the NSF's existing broadening participation programs into a single comprehensive framework.

I thank all the witnesses for being here today and I look forward to your testimony.

[The prepared statement of Vice Chair Fudge follows:]

PREPARED STATEMENT OF VICE CHAIR MARCIA L. FUDGE

Good morning and welcome to today's Research and Science Education Subcommittee hearing on broadening the participation of individuals from underrepresented groups in STEM fields. In the last three years, this Subcommittee has held four hearings focused specifically on the barriers to increasing the interest and participation of women in STEM. Today, we want to get a better understanding of the unique obstacles faced by individuals from different racial, cultural, and socioeconomic backgrounds, and hope to identify both common challenges and opportunities to widen the STEM pipeline. As many of you know, we are in the process of examining the state of National Science Foundation programs authorized under the 2007 *America COMPETES Act*, with the goal of strengthening the NSF's research and education missions, including programs related to broadening participation.

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I thank all the witness for being here today and I look forward to your testimony.

Ms. FUDGE. The Chair now recognizes Dr. Ehlers for an opening statement.

Mr. EHLERS. Thank you, Madam Chair.

Today's hearing is indeed an opportunity to gain insight into how Congress can best support participation of underrepresented minorities in science, technology, engineering and math. While we have had success with some of the Federal programs targeted at attracting and retaining these students in STEM, the overall numbers are still discouraging. Strengthening STEM education is essential to the future of American economic competitiveness and it is also essential to the future of the students involved because that is where the jobs will be, and we must prepare our students for the jobs of the future. The lack of underrepresented minority participation in these areas is a great hindrance that must be remedied.

The National Science Foundation has requested almost $800 million in fiscal year 2011 for programs with a specific focus or an emphasis on broadening the participation of underrepresented groups in STEM education and research. I am curious to learn how program successes can be leveraged and what changes are needed for us to consider. In particular, the consolidation that has been proposed as a matter of concern to me and I think everyone. I am not automatically against the change, it is just that I believe we have to carefully examine what this implies and what the likely results will be.

It is my hope that the witnesses testifying today will offer this committee insight into ways to better support STEM education for all students as we continue to explore the appropriate Federal role. I look forward to the testimony of our distinguished panel. I thank each and every one for being here today. Thank you.

[The prepared statement of Mr. Ehlers follows:]

PREPARED STATEMENT OF REPRESENTATIVE VERNON J. EHLERS

Today's hearing is an opportunity to gain insight into how Congress can support participation of underrepresented minorities in science, technology, engineering and math. While we have had success with some of the Federal programs targeted at attracting and retaining these students in STEM, the overall numbers are still discouraging. Strengthening STEM education is essential to the future of American economic competitiveness, and the lack of underrepresented minority participation in these areas is a great hindrance that must be remedied.

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Thank you, Mr. Chairman.

Ms. FUDGE. Thank you, Dr. Ehlers.

If there are Members who wish to submit additional opening statements, your statements will be added to the record at this point.

[The prepared statement of Ms. Johnson follows:]

PREPARED STATEMENT OF REPRESENTATIVE EDDIE BERNICE JOHNSON

The report, "Rising Above the Gathering Storm", along with others, showed that our Nation is as not graduating as many STEM professionals as other countries. Members of this committee are interested in correcting the reasons we are falling behind.

For this reason, I along with many others on this committee today introduced the original COMPETES bill which was signed in to law on August 9th, 2007. Today, nearly three years later we now are beginning to see some of these critical programs take effect.

Mr. Chairman, the fraction of college age population ages represented by minorities is expected to grow to 55 percent in 2050. The proportion of STEM bachelor's degrees earned by minorities is much lower than the representation of minorities within the U.S. population. In order to keep America competitive in fixture years, we have some work to do.

Many policymakers, educators, and other professionals worry that the ability of the United States to produce enough scientists will fall short unless action is taken to develop the potential of under-utilized minorities. In order for our Nation to remain competitive, a more diverse group of students must be recruited to science study and be equipped to thrive.

Women also continue to be under-represented in most STEM fields, we must do more to create opportunities to educate and retain them, especially at the university faculty level. A National Academies publication called, "Beyond Bias and Barriers: Fulfilling the Potential of Women in Academic Science and Engineering," provides specific policy directives to help accomplish this goal.

Based on the National Academies' recommendations, I introduced the Fulfilling the Potential of Women in Academic Science and Engineering Act. I believe this legislation is a good step in the right direction. We must obtain gender equity in the sciences.

NSF "Broadening Participation" programs are particularly effective in encouraging women and under-represented minorities to pursue STEM careers. I note that the Administration's 2011 Fiscal Budget proposes to drastically alter these critical programs at NSF by combining them under one umbrella in a wide-ranging program to compete for funding.

I, along with many of my Colleagues on the Congressional Black Caucus and the Diversity and Innovation Caucus are concerned that this proposal may *decrease the effectiveness of individual programs* which engage students at Historically Black, Tribal, and Hispanic-serving colleges.

In 2007, I offered an amendment which was incorporated in the original America COMPETES law which "directs the National Academies of the Sciences to compile a report, to be transmitted to the Congress no later than one year after the date of enactment of this Act, about barriers to increasing the number of underrepresented minorities in science, technology, engineering and mathematics fields and to identify strategies for bringing more underrepresented minorities into the science, technology, engineering and mathematics workforce."

It concerns me and others on this committee that nearly three years later this report is yet to be seen. As legislators, we have seen the statistics showing minorities are falling behind the rest of the pack in the sciences. We are now interested in policy directions to correct these statistics. I am keenly interested in hearing the expertise of today's witnesses. Mr. Chairman, I yield back.

Ms. FUDGE. At this time I would like to introduce our witnesses. Dr. Shirley Malcom is the head of the Directorate for Education and Human Resources Program for the American Association for the Advancement of Science. Dr. Alicia Dowd is an Associate Professor of Higher Education as well as Co-Director of the Center for Urban Education at the University of Southern California. Dr. Keivan Stassun is an Associate Professor of Physics and Astronomy as well as the Co-Director of the Fisk-Vanderbilt Master's-to-Ph.D. Bridge Program at Vanderbilt University. Dr. David Yarlott is the President of Little Big Horn College and Chair of the Board of Directors for the American Indian Higher Education Consortium. And lastly, Ms. Elaine Craft is the Director of the South Carolina Advanced Technological Education National Resource Center at Florence Darlington Technical College in South Carolina. Welcome, all.

As our witnesses should know, we will each have five-minutes— you will each have five minutes for your spoken testimony. Your written testimony will be included in the record for the hearing. When you all have completed your spoken testimony, we will begin with questions. Each Member will have five minutes to question the panel.

We will start with Dr. Malcom.

STATEMENT OF DR. SHIRLEY M. MALCOM, HEAD OF THE DIRECTORATE FOR EDUCATION AND HUMAN RESOURCES PROGRAMS, AMERICAN ASSOCIATION FOR THE ADVANCEMENT OF SCIENCE

Dr. MALCOM. Thank you for the opportunity to testify today on the critically important topic of broadening participation in science, technology, engineering and mathematics, or STEM. With Congressman Ehlers announcing his retirement, I would like to thank him for his strong and steadfast support for STEM education.

I will focus my remarks on women, minorities and persons with disabilities in STEM. At the bachelor's level, women are near or above parity in most STEM fields except physics, computer science and engineering. Even though the doctorate numbers have increased, women are not present among STEM faculty at levels that might be expected.

In trying to understand the patterns of any group in any field, it is important to look at the levels of representation as well as the trends over time. The levels of bachelor's degrees for women in engineering and computer science are about the same, around 20 percent, but that 20 percent represents a slight improvement over the decade in engineering and a significant decline in computer science, far below its all-time high of 37 percent in 1984.

It is important to unpack the numbers in order to understand how to move them. In the physical sciences, if we look at minority participation, it is driven by the chemistry numbers. Physics numbers remain low. Underrepresented minorities' improvement is actually being driven by women, with underrepresented males underparticipating in all fields as well as in STEM. The numbers have been moving in part because of programs such as the National Science Foundation's Louis Stokes Alliance for Minority Participation and the HBCU–UP [Historically Black Colleges-Universities Undergraduate Program] well as the more programs at the National Institute of General Medical Sciences in the NIH [National Institute of Health].

Persons with disabilities have been recognized by AAAS for about 35 years as a community that deserves special focus and intervention in STEM education and careers. We are not able to present the same kind of data as we are for participation of this community as we did for women and minorities, however. The issues here deserve more focus as we consider how to support, with education and training, U.S. veterans who are returning from combat in Iraq and Afghanistan with significant disabilities.

How did we get to this point—modest improvement without parity in participation? At the K–12 levels, there are failures in policy at every level, from the individual school and district to the State and Federal Government. The initiatives that have been proposed are steps in the right direction's but by themselves they are not enough. We have to build out beyond schools to support learning, not just education. AAAS has experience in engaging community-wide initiatives and is convinced that such approaches have merit. But we have to be careful not to become fixated on the idea that you have got to fix K–12 before you can move the numbers in STEM. We know too many examples of where that is not the case. Even with strong K–12 performance, young women get lost to STEM, and even with inadequate K–12 preparation many minority-serving institutions are able to move underrepresented minorities into STEM. So this is not a simple story.

College pathways differ for students from different population groups. Many students go to community college because of cost or geographic proximity. These schools have large enrollments of underrepresented minorities. They play a significant role in the education of teachers and in the retraining for the new economy.

In days when the state institutions were segregated by law, HBCUs [Historically black Colleges and Universities] were really the only options in higher education for many black students in the South. But even as students have begun to exercise other options with regard to undergraduate education, HBCUs remain the leaders as the top baccalaureate origin institutions for black students who received STEM doctorates between 2003 and 2007.

A number of institutions have been designated as Hispanic serving. Except for those in Puerto Rico, however, few of these institutions were expressly established to address the political, social and cultural needs of these populations.

Producing leaders for STEM means we must pay attention to the doctoral numbers. At present, there is reason for concern about Ph.D. production of domestic students, period, in all fields of engineering as well as in mathematics, physics and computer science, where in 2007 temporary residents received over half of all doctorates in those fields.

We have enjoyed progress at the doctoral level and beyond because of programs from the NSF such as the Alliances for Graduate Education and Professoriate.

But moving ahead, I want to announce five concerns. The fragmented nature of the Federal response that begs for coordination at an NSTC-like [National Science and Technology Council] level, the scale of the resources that are being expended that do not approach the scale of the problems that are to be addressed. The consolidation, I believe, is ill advised at this point. We have some fields that are especially difficult, such as physics and computer science, that warrant special attention, and in the faculty and advancement issues we must be attentive to the fact that we need to diversify our faculty at the same time in order to accomplish the diversification of our student populations. Thank you.

[The prepared statement of Dr. Malcom follows:]

PREPARED STATEMENT OF SHIRLEY M. MALCOM

Chairman Lipinski, Ranking Member Ehlers and members of the Subcommittee, thank you for the opportunity to testify today on the critically important topic of broadening participation in science, technology, engineering and mathematics (STEM).

The American Association for the Advancement of Science (AAAS) is the largest multidisciplinary scientific society and publisher of the journal *Science.* The association encompasses all fields of science, engineering, mathematics, biomedicine and their applications. Our commitment to and involvement in education extends from pre-Kindergarten through post-graduate and into the workforce.

Women in STEM

I want to begin my discussion of this topic with some evidence that this is an important policy issue that deserves national attention. In 2006 women received almost 58 percent of all bachelor's degrees awarded in the United States and almost 51 percent of the bachelor's degrees awarded collectively in science, technology, engineering and mathematics, the so-called *STEM* fields. Their representation in STEM ranged from highs of over 77 percent of psychology and almost 62 percent of biological sciences bachelor's degrees to lows of 19.4 percent and 20.2 percent, respectively, of engineering and computer science bachelor's degrees. (See Figure 1).The story of participation that each field tells is an interesting one. Among the low performing fields, for example, the engineering levels represent a slight improvement from a decade ago; but the representation in computer science has declined from the percent of women in the field a decade ago.

In trying to understand the patterns, it is important not only to look at levels of representation, but also at trends over time. Are things better or worse? And what accounts for the patterns that we see? Broad field designations can hide a "multitude of sins." For example, the representation in the physical sciences is driven by increases in chemistry, where women received almost 52 percent of bachelor's degrees in 2006, as opposed to physics, where they received less than 21 percent. Similarly in the social sciences, women received about 31 percent of bachelor's degrees in economics and 70 percent of such degrees in sociology in 2006.

Underrepresented Minorities in STEM

Un-packing the numbers is critical to understanding how to move them. This is even more the case when considering participation of minorities in STEM. Interestingly, underrepresented minorities are as likely to be present among the STEM bachelor's pool as they are among the pool for all fields. In 2006 African Americans received 9.1 percent of all bachelor's degrees awarded and 8.7 percent of STEM bachelor's degrees, this while representing 12.4 percent of the total population in the United States. Hispanics, meanwhile, received 8.1 percent of all bachelor's degrees and 8.0 percent of STEM bachelor's degrees. American Indians/Alaskan Natives received 0.7 percent of all degrees and 0.7 percent of STEM bachelor's degrees in 2006. On the other hand, Asian Americans/Pacific Islanders are more likely to be in the STEM pool than their representation among all bachelor's degree recipients in 2006, 9.7 percent versus 6.7 percent, respectively. White, non-Hispanic degree recipients received 67.2 percent of STEM bachelor's degree and 69.7 percent of bachelor's degree recipients for all fields. It should be noted, however, that White, non-Hispanic recipients of bachelor's degrees in STEM represent a declining proportion of degree recipients over the past decade, while the reverse is true for all other groups.

Another important trend for underrepresented minorities is that their present levels are being driven by women. Underrepresented minority males are under-participating in all fields including STEM. Again, as we look at the individual groups we see a vast set of differences within and across fields. For African Americans, participation levels ranged from highs of 11.6 percent of bachelor's degrees in computer science, 10.5 percent in psychology and 10.3 percent in social sciences to lows of 1.5 percent and 2.8 percent, respectively in earth, atmospheric and ocean sciences and agricultural sciences. For Hispanics, representation levels were highest for bachelor's degrees in psychology (9.4 percent) and social sciences (8.9 percent) and, as for African Americans, lowest in earth, atmospheric and ocean sciences, and agricultural sciences at 3.6 percent and 3.8 percent, respectively (See Figure 2).

Once again, broad fields hide wide variations of participation. For example, African Americans received 6.6 percent of 2006 bachelor's degrees in the physical sciences. This representation is being driven by chemistry, where they received 7.6 percent of degrees awarded. In contrast, they received 3.7 percent of 2006 physics bachelor's degrees. Interestingly, of 166 bachelor's degrees awarded in physics to African Americans in 2004, 49 percent of these were awarded by Historically Black Colleges and Universities (HBCUs). *http://www.aip.org/statistics/trends/highlite/minority/table5.htm*

For Hispanics in the social sciences, the 10.3 percent of bachelor's degree in 2006 conceals the differences in participation between economics, where they represented fewer than six percent of degree recipients, and sociology, where they received well over ten percent of bachelor's degrees.

Persons with Disabilities in STEM

Persons with disabilities have been recognized by AAAS for almost thirty-five years as a community that deserves special focus and intervention in terms of STEM education and careers. Yet we are unable to present the data on participation for this community as we did for women and minorities. This lack of systematic data makes it difficult to paint a clear picture of the presence of members of this community within STEM education or workforce and to identify field-specific obstacles.

Our extensive networks of and experiences with the community of scientists and engineers with disabilities have led us to a number of conclusions as to the needs and potential of persons with disabilities in STEM:

- Today, advances in medical science, cognitive interventions and assistive technologies have made it possible to take advantage of the talent and perspectives available for STEM that are resident among persons with disabilities more than ever before.
- The focus within STEM on "ability rather than disability" makes these fields attractive career and employment options for persons with disabilities.
- The major barriers to persons with disabilities are often in the area of "employment," though AAAS has developed a number of partnerships with government and the private sector, where we have been able to successfully place scientists and engineers with disabilities in internships, many leading to full employment and advancement potential.

The issues here deserve more focus particularly as we consider how to support, with education and training, U.S. veterans who are returning from combat in Iraq and Afghanistan with significant disabilities.

A Total Pathways Perspective

Although I began this testimony focusing on bachelor's degrees in STEM for under-participating groups, I want to acknowledge the larger issues of "pathways to STEM," from K–12 education to graduate education leading to the doctoral degree.

A Focus on K–12

Many of the challenges with retention and time to degree for underrepresented minority students can be traced back to inadequate early preparation in K–12:

- Students who leave high school without the prerequisites for success in college, such as four years of rigorous mathematics and science instruction.
- Lack of access to Advanced Placement courses.
- Attendance in schools with poor facilities and poorly prepared faculty.
- Lack of expectations for students to enter and be successful in STEM fields.

And the list goes on. In many cases these factors relate to failures of policy at every level, from the individual school and district to the state and Federal Government, from local teacher placement and assignment policies to a focus on meeting No Child Left Behind requirements to the exclusion of opportunities for learning. Proposed initiatives to provide resources to support STEM education transformation, to increase standards, to push for more rigorous courses, and to require accountability by disaggregated groups are steps in the right direction. But, by themselves, they are not enough. Engagement with the resources of entire communities, colleges and universities, youth-serving groups, faith-based groups and others is needed. Students actually spend a small fraction of their waking hours in formal education settings. We must build out beyond schools to support **learning,** not just education. AAAS has experience with engaging such groups in "community-wide" initiatives, and we have evidence that such approaches have merit.

Community Colleges

There are many roads that students take, whether they are "traditional" students who enter higher education immediately following high school or so-called "non-traditional" students who pursue such education some years after completion of high school or acquiring a GED.

The pathways to STEM education and careers via community colleges are different for students from different population groups. Over 38 percent of African American, 51 percent of Hispanic and 42 percent of American Indian/Alaskan Native students are enrolled in community colleges. In addition, 20 percent of those who go on to become teachers begin in community colleges. Fifty percent of teachers attended community college at some point, and about 40 percent completed some of their mathematics and science preparation in the community college.

All of these factors cry out for more focused attention on this critical component of the STEM pathway. Many students choose to go to community college because of the lower cost of such institutions; others choose to attend community colleges for reasons of proximity to their home community. The older age of typical community college students is indicative that many individuals use the institutions as a "second chance," for retraining and/or seeking new educational and career prospects. Students who are under-prepared often use the open access to community colleges as a way to make up the deficiencies; still others, especially in states where there is strong competition for slots in the university system, take advantage of the rules around "articulation" to access the university. Whatever the reason, one cannot consider the pathways to STEM without considering the role of community colleges. Tribal colleges represent a special case, serving populations that are geographically isolated in ways that respect local needs and cultural traditions.

HBCUs and HSIs

Other roads to STEM come through Historically Black Colleges and Universities (HBCUs) and Hispanic Serving Institutions (HSIs). In the days when state institutions were segregated by law, HBCUs were the only options for higher education for Black students, especially in the South. As options opened up for African American students to attend previously all-White institutions in the region, the proportions of African American undergraduates who were enrolled in HBCUs fell, from 30 percent in 1976 to 18 percent in 2006. Yet, despite the shifting population of African American students in higher education, including some of the most competitive students, HBCUs outperformed other institutions in the proportion of 2004 bachelor's degrees awarded to African Americans in chemistry (39 percent) and mathematics (37 percent) and remained leaders as the top 10 baccalaureate origins institutions for Black students who received STEM doctorates between 2003 and 2007. *http://www.nsf.gov/statistics/wmpd/pdf/tabf-7.pdf*

A number of institutions have been designated as "Hispanic-serving." Except for those in Puerto Rico, however, few of these institutions were expressly established to address the political, social and cultural needs of these populations. Their designation has emerged over time as their demographics have changed. And many such institutions have, in like manner to HBCUs, emerged as disproportionate contributors to STEM fields and as baccalaureate origins institutions for Hispanics who received STEM doctorates. A mixed group of HSIs and non-HSIs made up the top 10 list of baccalaureate origins institutions. *http://www.nsf.gov/statistics/wmpolpdf/tabf-8.pdf*

The Road to the Doctorate and Beyond

Attending to the issue of Ph.D. degree production for women and underrepresented minorities depends, of course, on the adequacy in numbers and preparation of the bachelor's degree production process, as well as the efforts that are made to attract, retain, mentor and support STEM students in graduate education (See Figure 3). While the progress in this arena has been slower than we have wished it is important to note the successes that have emerged due, in part, to a number of NSF-funded programs.

Prominent among the efforts to increase the numbers of underrepresented minority doctorates in STEM is the NSF Alliances for Graduate Education and the Professoriate (AGEP). For over ten years, AAAS has been the research arm and technical assistance provider to AGEP. In this role we work with our partner, Campbell-Kibler Associates, to collect data on enrollment and degree production from the individual Alliance institutions and monitor and report on the collective findings. The most recent report, released in February 2010, indicates an almost 50 percent increase in the average number of Ph.D.s awarded to underrepresented minorities in natural sciences and engineering fields over the three year period 2007–09 when compared with the average for the baseline years of 2001–03.

This is a stunning result and points to what is possible when research, monitoring, use of collaborative, evidence-based models and institutional leadership and commitment come together. Of course questions could be raised about the output of non-AGEP institutions among doctoral degree granting institutions, especially given the regular research support that most receive from Federal and other sources. Some examples of critical questions of commitment that need to be addressed are: the significant levels of graduate school debt that underrepresented minority students incur on their way to the doctorate; the primary forms of support that they indicate (e.g., less likely to indicate research assistantships); and the adequacy of the mentoring they receive. Often the stories that emerge are those related to isolation and failure to find community.

Women's presence within the doctoral population is more significant, though this differs greatly by field. In 2007, women received over 50 percent of doctorates in all fields and over 40 percent of STEM doctorates. Women were 49 percent of biological sciences doctorates and almost 73 percent of psychology doctorates. But they were only 20.9 percent of engineering doctorates and 20.5 percent of computer science doctorates. Compared with participation levels in 1998, there have been gains in all fields surveyed (See Figure 3).

Women have received a significant proportion of STEM doctorates for well over a decade. Yet they are not appearing among the STEM faculty, especially among leading research institutions, at proportions that should reasonably be expected given their presence in the available pool of candidates; nor are they being retained and advanced in the ranks. Another NSF-funded program has taken on the challenge of addressing these issues. ADVANCE has focused on the institution-specific challenges of understanding and affecting the policies and processes that govern identifying, recruiting, hiring and promoting faculty as well as the

system impediments that often lead to the loss of talented women faculty. These would include issues such as: parental leave and "stop the clock" policies; spousal/partner hires; transparency of the requirements for promotion and tenure and so on. Many of the obstacles relate to the desire for women (and men) to be able to integrate the personal/family and career aspects of their lives.

Recent Nobel Laureates Elizabeth Blackburn and Carol Greider addressed these issues directly in interviews after the announcement of their award as they talked about the need for institutions to reconsider the male models upon which the job expectations of STEM faculty are based; e.g., to consider part-time (as well as part-time tenure track) and other more flexible arrangements. This is not an issue of being able or "good enough" to do the science. And separating the aspects of careers that are necessary and those that are simply “tradition” has been a critical component of department and institutional reviews and responses. Often included in this work have been studies of the “climate” and attitudes that surround the departments and decision making regarding hiring and promotion. While every ADVANCE grant has been differently focused to respond to the particulars of each institution, the focus of all has included research and evidence-based models that can then inform programs and practices.

Some data are available on STEM doctorates with disabilities. Looking just at STEM doctorate recipients who reported disabilities in 2007, we find “learning” and “physical/orthopedic” disabilities as the leading forms of disabilities reported. They were less likely than persons without disabilities to have received their doctorates in STEM fields (over 66 percent versus over 51 percent of all degrees awarded). The leading field for Ph.D.s for both doctorate recipients with and without disabilities was biological sciences (11.2 versus 15 percent of all doctorates awarded, respectively).

In STEM fields, postdoctoral experiences provide important training in conducting independent research and establishing a research agenda: functions that are critical to becoming a STEM faculty member. Not much is known about the postdoctoral experiences of minority and women scholars; however, it is essential that underrepresented groups benefit from mentoring from STEM faculty in Research I universities.

Greatest Challenges to/Needs for Achieving Diversity in STEM

The processes of providing quality education to all in STEM, to enabling individuals to choose careers in these fields and to supporting the success of STEM professionals are many and complex. Challenges to broadening participation in STEM vary by group, by field and level, but include many of the issues listed below.

K–12 STEM Education (Issues affect especially underrepresented minorities and persons with disabilities)

- Quality of K–12 education (rigorous standards and courses and appropriate support, facilities, technology and other resources to meet these standards)
- Preparation of students in mathematics and science as well as reading
- Teachers who are well prepared to support student learning in STEM and who have high expectations of all students
- Access to the right K–12 courses and to career guidance
- Opportunities for out-of-school experiences to reinforce STEM learning and careers

Undergraduate STEM Education

- Better introductory courses and better teaching: focusing on cultivating an interest rather than weeding students out
- Early access to experiences that support SIEM, including undergraduate research
- Financial access to institutions of higher education for STEM students
- Debt as a deterrent to continuous enrollment, progress to degree and consideration of graduate study
- Support for community colleges to enable them to more adequately play a pathway role, including better articulation
- More support for institutions that are shouldering a disproportionate role in bringing underrepresented minorities to STEM
- More accountability on Research I institutions to take responsibility for student success in STEM
- Real physical and attitudinal accessibility to STEM programs (“beyond the ramps ”)

Graduate-level and Beyond

- Provide a “mix” of support that research has deemed most effective in ensuring student progression through to the doctorate, including fellowships/traineeships, research assistantships, and teaching assistantships
- Burden of rising tuition rates and creating mechanisms to reduce debt
- Isolation and lack of supportive environment and effective mentoring
- Need for skill building that addresses other aspects of job requirements, beyond research

- Encouragement and career guidance, including more guidance on what students can do outside of academia
- Opportunities for network development, publishing, presenting and interacting in a global environment
- Opportunities for post-doctoral experience to support career development

Workforce

- Flexibility in the structure of employment and positions (e.g., part-time, shared, etc.)
- Valuing diversity and what it brings to the workplace, the classroom and the lab
- Transparency in expectations and in what is needed for promotion
- Fair and transparent processes in hiring, promoting and advancing, especially with regard to STEM faculty

Issues Specific to Persons with Disabilities

- Definitional issues, including the situation for individuals with apparent vs. non-apparent disabilities
- Disclosure concerns (risking discrimination or shifts in attitude, e.g., with the disclosure of a non-apparent disability)
- Issues regarding age of onset of disability and its differential impact on education and careers
- Generational differences (the situation is quite different for persons who began education and/or careers prior to the passage of laws related to non-discrimination)
- Differences related to presence and/or availability of assistive technology which can ameliorate (though never cancel) the impact of a disabling condition

AAAS Efforts to Broaden Participation in STEM

AAAS has a long history of efforts to increase the participation of girls and young women, underrepresented minorities and persons with disabilities and to enhance the status of these groups in science, technology, engineering and mathematics—The association has communicated this commitment to equal opportunity through its mission statement, its programs, and its governance. This work is consistent with the AAAS mission to "advance science, engineering, and innovation throughout the world for the benefit of all people." To fulfill this mission, the AAAS Board has set out broad goals that include strengthening and diversifying the science and technology (S&T) workforce and fostering education in science and technology for everyone.

The AAAS Directorate for Education and Human Resources that I head combines concerns around diversity of the STEM community with issues related to strengthening STEM education for **everyone,** from pre-K to post-graduate, and public engagement to promote STEM literacy overall, with special attention focused on efforts to:

- Increase participation of women, underrepresented minorities (African Americans, American Indians and Hispanics) and persons with disabilities in science, mathematics, engineering and biomedical education and careers.
- Heighten the visibility and promote the advancement of these groups in STEM.
- Raise awareness and recognition of the barriers faced by these groups and help to remove them.
- Increase the involvement of these groups within the activities of the AAAS as well as in the larger STEM enterprise.

We make progress in these areas by exploring how programs, policies and practices combine to determine the shape of STEM. While we work **across** the issues presented for the different groups we work to understand where concerns may overlap as well as where they may differ. We know that context matters and that it is important to know when we should "lump" as well as when we must "split." For example, we came to understand quite early that the situation for minority women in science and engineering is unlike the situation either for White women or for minority men, and that even within the category of minority females, differences of history, culture and expectations play a key role. On the other hand, the lack of transparency in university hiring and promotion has a detrimental effect on the retention of all underrepresented groups, and this concern may be addressed as a single issue or a "theme with variations."

We have pursued models that have been attentive to differences and similarities in our search for effective strategies for addressing different elements of the complex ecosystem of STEM education and careers. And at every turn, even as we target, we work to effectively mainstream issues related to diversity.

In many ways we credit our work with persons with disabilities for bringing this aspect clearly into focus. While *persons with disabilities* may be the programmatic and statistical category that we use, the needs of each individual are unique given the "particularistic" nature of each disability and especially as these play out in each educational or job setting. A person may have a disability, but a person can also be disabled by an unsupportive environment.

Overview of AAAS Programs

Teachers for Diverse Student Populations. We have developed projects to cultivate teacher leaders in mathematics and science for middle schools in the District of Columbia through a master's program developed in collaboration with George Washington University, funded by the Office of the State Superintendent of Education. In this program veteran teachers get critical subject matter instruction as well as courses that focus on emerging insights in the learning sciences, effective pedagogy and the use of technology. The emphasis is on developing "change agents" who can work with their peers to improve student performance in schools serving diverse student populations. We not only affect area schools; we also develop and test interventions as possible national models.

Careers for the Future. Another current project is focusing on introducing students, their parents, teachers and counselors to STEM careers, looking especially at those related to energy and the environment. This NSF-funded ITEST project introduces quality curriculum, career exploration, appropriate role models, projects, and a focus on learning both in and beyond the school day. We are interested not only in undertaking the project, but also in learning from it. For example, does it make a difference to have learning coherence across a program, and does "dosage" matter? That is, what is the difference in the learning of students who are engaged in multiple program elements?

Learning in Out-of-School Environments. We use science and technology-focused clubs and "gaming" to support student learning. We have been able to demonstrate through evaluations of our Kinetic City out-of-school clubs, for example, that students not only learn the science, but they also improve in reading and writing. "**Find out what will work, and make it as accessible as possible,"** has been a guiding principle of our work.

Undergraduate Teaching. At the level of higher education, through a current partnership that involves both disciplinary and education units of the National Science Foundation along with HHMI and the MORE Division of NIGMS of NIH, we are working to address the larger issue of the quality of introductory college courses in biology. We are a partner in bringing together a community of practice that seeks to create a movement to develop courses that will more effectively engage students and advance their understanding of the nature of science, instead of courses that turn them off and leave them "science averse."

Building Institutional Capacity. Returning to the notion of the "personalized nature" of barriers and opportunities, nowhere is this issue more clear than in the work of the **AAAS Center for Advancing Science and Engineering Capacity** directed by Dr. Daryl Chubin. This "fee for service" consulting organization, embedded within AAAS, works with institutions to help them build internal capacity to respond to the need to better serve all STEM students and to diversify their student populations and faculty. Center staff and consultants help to move lessons learned across institutions even as they address the needs of particular departments, schools and colleges. Center clients have included many different types of institutions (e.g., an undergraduate research program at Harvard; a "scholars" program at LSU) and funded programs (e.g., NSF GK–12; NSF Broadening Participation in Computing). The work has included evaluation, technical assistance and training.

Currently the Center is engaged in addressing an issue that touches every higher education institution in the country. Given the current structure of laws, regulations and court decisions, how do institutions put in place programs, policies and practices to achieve diversity among undergraduate and graduate STEM student populations and faculty that are both **effective and legally defensible?**

Early efforts (from the mid-1960s through the 1970s) undertaken by colleges, universities, school systems, agencies and others to broaden participation in STEM often took the form of so-called "special programs," projects set aside for different groups to respond to the particular challenges and barriers that each circumstance might present. A series of district and Supreme Court decisions, along with the passage of anti-affirmative action referenda in a number of states, raised serious concerns as to whether certain practices and programs might be able to withstand legal challenge. For example, in the 1995 post-*Adarand* review of programs at the Federal level, a number of NSF programs were discontinued.

In universities, post-*Adarand* concerns and the absence of guidance after the *Grutter* v. *Bollinger* and *Gratz* v. *Bollinger* Michigan decisions of the U.S. Supreme Court led to confusion in universities about what was and was not allowed. Outside of clarifying what was permissible in admissions decision-making the rulings were silent in addressing concerns related to aspects so critical in STEM education such as outreach and support programs. It was not clear how the institutions might capture the educational value of diversity noted by Justice O'Connor and address the national need to develop a diverse STEM workforce.

Following a conference held in 2004, in partnership with the National Action Council for Minorities in Engineering (NACME), and co-publication in the same year of *Standing Our Ground: A Guidebook for STEM Educators in the Post-Michigan Era,* we began to consider what more could be done to help clarify what might be possible to advance STEM diversity even in light of legal and judicial constraints.

AAAS and NACME co-sponsored a meeting in 2008, with the support of the Alfred P. Sloan Foundation that included academic, corporate and legal representatives to discuss the legal barriers to and the compelling national interest of advancing diversity in STEM. From that gathering was born the idea of undertaking a deep analysis, both legal and programmatic, to identify initiatives and practices capable of satisfying both requirements for effectiveness and legal defensibility.

This initial meeting has resulted in follow-up workshops with continued support from Sloan and now the National Science Foundation as well as AAAS and our partner organization, the Association of American Universities (AAU). The project has:

- Identified and partnered with two law firms who, through considerable pro bono work, have identified the bodies of law that applies both to student and faculty employment issues.
- Developed materials to guide institutional leaders through the analysis of the law and its implications as related to diversifying STEM students and faculty.
- Conducted a pilot workshop with ten AAU institutional teams, including the general counsel and provost or representative of each institution.
- Revised and refined the materials in response to feedback.
- Held a second workshop to disseminate the materials as well as to test the format of the sessions.

In these workshops there are opportunities for extensive networking among counsels and provosts, and chances to consider issues from both education/mission concerns as well as through a legal frame. We are currently seeking support to enable us to adapt the materials and case studies to other types of institutions and to expand the dialogue beyond the research universities that belong to AAU. A number of higher education organizations have written letters of support and signaled their interest in having this work extended to their membership.

The Federal Role in Broadening Participation

President Obama has articulated both the need for attention to education in STEM and the value of engaging the broadest base of talent in these fields. This leadership, coupled with coordination across the Federal Government and thoughtful implementation of evidence-based efforts, can do much in addressing broadening participation in STEM.

Improving K–12 Education for All. Effective implementation of Race to the Top, for example, by emphasizing STEM and success for all students in science, mathematics and literacy, could over time affect the challenge of weak preparation that too many minority students bring to higher education. But it will be important to know that the affected populations are being served, that attention to diverse learners is a part of the overall strategy, and that communities are engaged beyond the school walls and the school day.

Coordination of Programs. At the same time that this support seeks to affect the infrastructure for learning from the statehouse to the school room, Federal science agencies and departments need to be able to support the development of programs and strategies that are "mission specific" and that can ensure that an expanded talent base also includes people who bring the skill sets specific to their mission and needs. Overarching this needs to be a coherent plan for talent expansion and development that is coordinated through an NSTC-type mechanism. This is not the time for misplaced concerns about the "duplication of effort." Any agency charged with carrying out a mission needs the authority to help construct the future human resources pool required to advance its mission.

Coherent Approaches to Community College Support. Given the fact that community colleges are enrolling so many underrepresented minority students, there is a need to carefully craft support strategies for these institutions that can enable them to do a better job, both of providing education in technical and allied health fields but also in the transfer of STEM students to four-year colleges and universities. There is a need to do this while being honest about the strengths that community colleges could bring to a total pathways approach to STEM and as access points for higher education, as well as about the weaknesses they currently display in moving such a small proportion of their STEM students to the next level. In many states expenditures for students in community colleges fall below levels for either K–12 or four-year colleges. Because these institutions are continually being called upon to do "more with less" and to serve so many different missions, injections of funding need to be targeted and purposeful to address the concerns relevant to smoothing the pathway to STEMM.

Money Matters. We have begun to understand how significant the financial impediments may be for those pursuing graduate study in STEM, and that the accumulation of undergraduate and graduate debt may be a serious deterrent to underrepresented minority and low-income students. Addressing the access and financial aid issues at both undergraduate and graduate levels is not just a matter of "throwing money," but merits thoughtful consideration as to the conditions surrounding support. For example, providing stipends associated with undergraduate research participation accomplishes at least four worthy outcomes at the same time: providing a positive educational experience; reinforcing a commitment to STEM and aiding in retention; providing a source of needed financial support; and linking students to potential mentors. At the graduate level mixed forms of support over time (a portable fellowship or traineeship coupled with a research assistantship, which may help reinforce mentoring relationships and build a publications record) may be the smartest form of investment. For many fields of science and all fields of engineering, domestic students of every race and ethnicity are falling further behind in receipt of doctorate degrees. We need to understand how debt and the opportunity costs of graduate education might be affecting these results. In cases where we are looking to the talent of the future to innovate and address global challenges of water, food security, health, climate change, loss of species diversity, and many others, we must invest in the development of the talent base.

Role of the NSF. As with the corporate leaders who in our 2008 workshop spoke so compellingly of the need to utilize the full extent of the nation's talent base to support STEM, we have acknowledged consistent commitment to the idea of broadening participation in STEM by the leadership of the National Science Foundation. The NSF has a special role, emerging from the mandate of its organic act as well as through the provisions of the Science and Engineering Equal Opportunities Act of 1980 to see to concerns related to STEM education the health of the human resources base for STEM.

Many of NSF's efforts are hitting the right targets (for example, Broadening Participation in Computing). Computing is an area in special need of attention. As noted earlier the participation trend lines for women in computer science, for example, are headed in the wrong direction. There is a real irony that women received their largest percentage (37.2 percent) of bachelor's degree in computer science in 1984! Since that time their participation has plummeted to a little over 20 percent. Meanwhile U.S. citizens and permanent residents received only about 37 percent of the Ph.D.s in computer and information sciences in 2008. AAAS, through the Capacity Center, has been a partner with the NSF program, assisting institutions to understand how to monitor and assess progress toward their goals.

The ADVANCE program has provided commendable leadership in helping institutions assess and address their processes, policies and procedures to support women faculty in the areas of hiring, promotion, tenure and development of family-friendly environments that ultimately benefit all. The program of Alliances for Graduate Education and the Professoriate (AGEP) has demonstrated what is possible in increasing the numbers of underrepresented minority Ph.D.s through supporting alliances of doctoral degree granting and minority serving institutions. The programs aimed at strengthening HBCUs and Tribal Colleges are affecting the capacity of those institutions to make a difference for their students in the quality of preparation and the diversity of fields of study. The Louis Stokes Alliances for Minority Participation (LSAMP) Program is helping to increase the bachelor's production of underrepresented minority students in STEM, fostering alliances of majority and minority institutions in the process. In the case of HBCUs we see the impact of their work as they make a disproportionate contribution to the STEM Ph.D. production of African Americans. And I anticipate that a carefully crafted program of support for HSIs with **demonstrated capacity to support the success of Hispanic students in STEM** could make a similar contribution.

The challenge is not the program goals themselves, but the modest scale of the investments! The programs need to be used as critical components to a portfolio approach to broadening participation. In the 2011 documentation to the proposed NSF budget, there is considerable language about consolidation of such programs. Looking at efforts to date it is not clear that such a major consolidation is desirable or prudent at this time. To what extent is the rest of NSF's budget being used in support of the integration of research and education in ways that support broadening participation? Why are the overwhelming majority of research universities doing so little to advance the broadening participation goals of the Foundation? Can we track the current impact of the "broader impacts" criterion on broadening participation goals?

How much is being invested in sharing lessons learned from program investments in broadening participation efforts beyond the community that is currently committed and active? At this point it is important to continue investing in initiatives that seek to identify and test effective broadening participation strategies in departments and institutions. At the same time we must transfer lessons learned in ways that mainstream the concerns into the directorates and divisions of the Foundation, and from them into the institutions they support, as part of the regular way that the NSF's business is done, without introducing "lethal program mutations" where the true intent or practices of initiatives are lost.

When undertaking any efforts at mainstreaming, it is crucial to monitor progress, to insist on the use of evidence-based strategies, and to provide technical assistance and capacity building. The risk is great in mainstreaming, however, of losing sight of the special and particular needs, histories and issues of different types of institutions, and different groups in the context of different fields. It is critical to know when to lump and when to split.

Despite the difficulty of doing the work related to broadening participation, there are institutions that have enjoyed some success in this goal while others have not. Leadership and political will must combine with successful strategies. There are effective efforts that can be mounted that are legally defensible. But first you must want to make a difference.

Appendix

Figure 1. Percent of Bachelor's Degrees Awarded to Women by Broad Field, 2006

All fields	All S&E	Engineering	Physical Sciences	Earth, atmospheric, ocean sciences	Mathematics and Statistics	Computer Sciences	Biological Sciences	Agricultural Sciences	Social Sciences	Psychology
58.1%	50.8%	19.4%	42.3%	41.1%	45.2%	20.2%	61.7%	51.4%	53.7%	77.4%

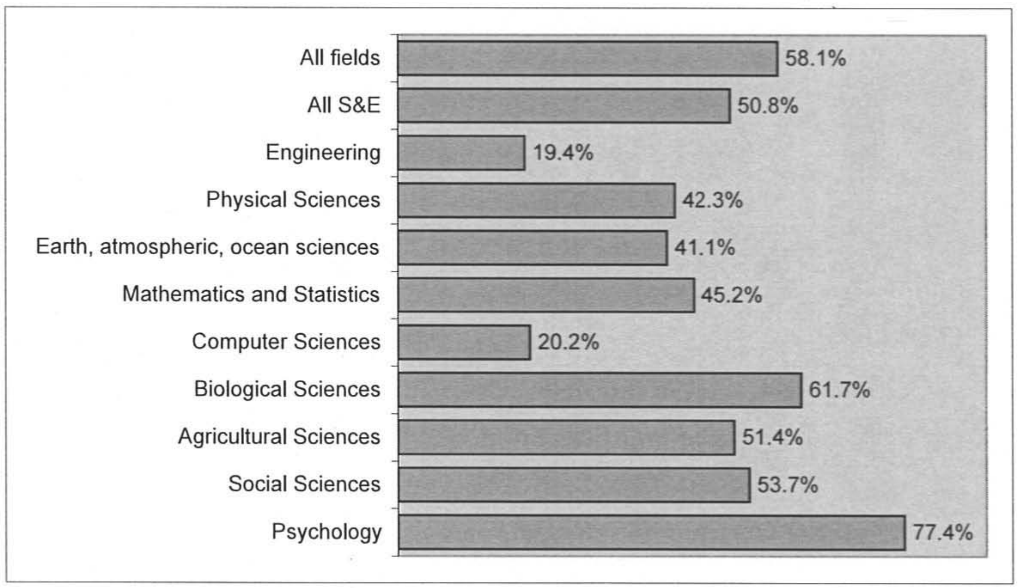


Figure 2. Percent of Bachelor's Degrees Awarded by Broad Field, 2006

	All fields	All S&E	Engineering	Physical Sciences	Earth, atmospheric, ocean sciences	Mathematics and Statistics	Computer Sciences	Biological Sciences	Agricultural Sciences	Social Sciences	Psychology
African Americans	9.1%	8.7%	5.0%	6.6%	1.5%	5.8%	11.6%	7.6%	2.8%	10.3%	10.5%
Hispanics	8.1%	8.0%	7.7%	6.3%	3.6%	6.0%	7.2%	7.2%	3.8%	8.9%	9.4%
AI/AN	0.7%	0.7%	0.6%	0.7%	0.9%	0.4%	0.6%	0.7%	1.1%	0.9%	0.7%
Asian/Pacific Islander	6.7%	9.7%	13.5%	10.4%	2.4%	10.0%	11.0%	14.2%	3.2%	8.5%	6.1%
White, non-Hispanics	69.7%	67.2%	68.6%	70.5%	85.9%	72.2%	60.7%	65.6%	84.5%	65.1%	68.4%

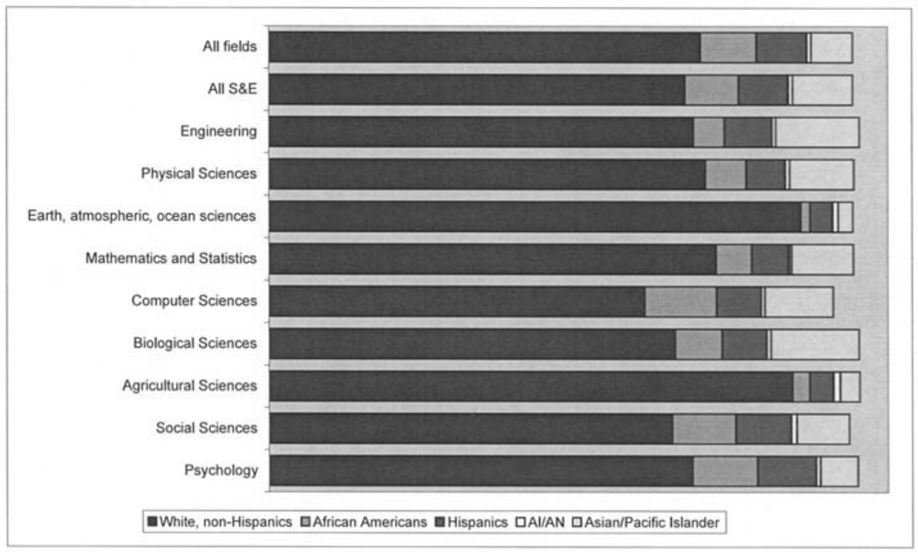
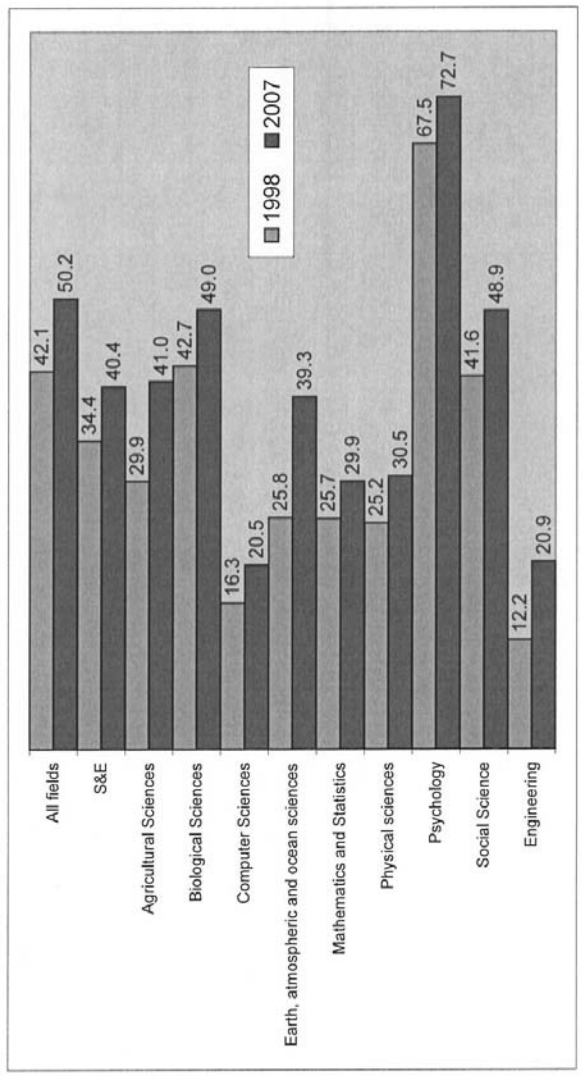


Figure 3. S&E Doctoral Degrees Awarded to Women by Broad Field, 1998 and 2007

	All fields	S&E	Agricultural Sciences	Biological Sciences	Computer Sciences	Earth, atmospheric and ocean sciences	Mathematics and Statistics	Physical sciences	Psychology	Social Science	Engineering
1998	42.1	34.4	29.9	42.7	16.3	25.8	25.7	25.2	67.5	41.6	12.2
2007	50.2	40.4	41.0	49.0	20.5	39.3	29.9	30.5	72.7	48.9	20.9



BIOGRAPHY FOR SHIRLEY M. MALCOM

Shirley M. Malcom is Head of the Directorate for Education and Human Resources Programs of the American Association for the Advancement of Science (AAAS). The directorate includes AAAS programs in education, activities for under-represented groups, and public understanding of science and technology. Dr. Malcom serves on several boards—including the Heinz Endowments and the H. John Heinz III Center for Science, Economics and the Environment—and is an honorary trustee of the American Museum of Natural History. In 2006 she was named as co-chair (with Leon Lederman) of the National Science Board Commission on 21st Century Education in STEM. She serves as a Regent of Morgan State University and as a trustee of Caltech. In addition, she has chaired a number of national committees addressing education reform and access to scientific and technical education, careers and literacy. Dr. Malcom is a former trustee of the Carnegie Corporation of New York. She is a fellow of the AAAS and the American Academy of Arts and Sciences. She served on the National Science Board, the policymaking body of the National Science Foundation from 1994 to 1998, and from 1994–2001 served on the President's Committee of Advisors on Science and Technology. Dr. Malcom received her doctorate in ecology from Pennsylvania State University; master's degree in zoology from the University of California, Los Angeles; and bachelor's degree with distinction in zoology from the University of Washington. She also holds 16 honorary degrees. In 2003 Dr. Malcom received the Public Welfare Medal of the National Academy of Sciences, the highest award given by the Academy.

Ms. FUDGE. Thank you.
Dr. Dowd.

STATEMENT OF DR. ALICIA C. DOWD, ASSOCIATE PROFESSOR OF HIGHER EDUCATION, UNIVERSITY OF SOUTHERN CALIFORNIA, AND CO–DIRECTOR OF THE CENTER FOR URBAN EDUCATION

Dr. DOWD. Representative Fudge, Ranking Member Ehlers and Members of the Committee, thank you for the honor of addressing you here today. My name is Alicia Dowd. I am Co-Director of the Center for Urban Education and I am a Professor at the Rossier School of Education at USC. I would like to start by talking about the current situation.

The Committee has taken up the issue of broadening diversity in STEM fields in an era of urgent need to improve the Nation's infrastructure, environmental sustainability, security and manufacturing. Yet currently we are experiencing a loss of talent from STEM as each year African American, Latina, Latino and American Indian students start their college studies as STEM majors, but then leave those fields at high rates. In alarming numbers, students across the country graduate from high school unprepared to do college-level mathematics and experience dead-end remedial classrooms in college. The students who have been most poorly served in their primary and secondary schooling are too often assigned the least well-prepared teachers in colleges with the lowest level of resources.

So the question is, what can we do about this situation? Some work has already been done. With funding from NSF and other Federal agencies, STEM faculty, administrators and counselors have built on research findings to develop model programs that help students navigate college and complete STEM degrees. These include supplemental instruction, orientation, summer bridge programs, peer tutoring and intrusive advising. However, these practices do not go far enough. Most problematically, they are typically focused on fixing students rather than on fixing instructional practices in STEM. They need to be supplemented with work at the core of higher education. This means in classrooms through curriculum reform and through new pedagogies.

We know that active learning, focused on real-world problem solving, engages students of all backgrounds. Research shows that African American, Latino and female students find added value in applying their scientific learning to problems of communities and society. To encourage active learning and applied problem solving in STEM, we need to invest in bold experiments that reorganize the curriculum and break down disciplinary silos.

But another major challenge must be acknowledged. The racial climate of STEM classrooms and programs is too often negative. Recent research documents that racial stigma and discrimination create significant barriers to the participation of underrepresented racial ethnic groups in STEM. To improve diversity, we must use the tools of culturally responsive pedagogy to dispel the negative racial climates created when students are treated as if they are all alike. One factor that perpetuates this issue is that our STEM teaching force is not as diverse as the student body. We teach as we were taught and unwittingly reproduce harsh campus climates that too often devalue racial and ethnic diversity. The new STEM teaching force should have the cultural competencies to dispel any sense of racial discrimination, bias or racial stigma. This is imperative.

The most important step NSF can take, therefore, is to fund interdisciplinary research of STEM pedagogy and the racial climate of STEM classrooms and learning environments. Scientists and social scientists can conduct studies together to determine the kind of professional development and support professors need to adopt new pedagogies. Change must come at the institutional levels and with prominent educational leadership. To enable this change, the development of rigorous and comprehensive evaluation strategies is needed. These must include evaluation of student outcomes, of program effectiveness in reaching performance benchmarks as well as evaluation of faculty development and organizational change processes.

Change cannot be limited to individual institutions. As the majority of Latino students are enrolled at community colleges today, to improve the participation of Hispanic students in STEM, structural reforms must cross the boundaries of two-year colleges and four-year universities to allow students to transfer and earn bachelor's degrees and graduate degrees. In addition, Hispanic students are heavily enrolled in Hispanic-Serving Institutions. Funding that enhances the mission focus and Hispanic-serving focus of these institutions will have a central role to play in improving Latina and Latino participation in STEM.

In closing, let me affirm that we do not face an aspirations gap among African American, Latina and Latino and American Indian students for participation in STEM. We have an opportunity and an education gap. Notably, we have the tools to close that gap if we have the will. I have no doubt that our investments in diversity in STEM will be repaid through greater productivity and innovation.

It has been my privilege to address this committee. I thank you for your attention to my remarks and I will be happy to elaborate on my comments or my written testimony in response to your questions. Thank you very much.

[The prepared statement of Ms. Dowd follows:]

PREPARED STATEMENT OF ALICIA C. DOWD

Chairman Lipinski, Ranking Member Ehlers, and members of the Committee, thank you for this opportunity to inform your deliberations concerning the issues of diversity in science, technology, engineering and mathematics (STEM). I am honored to share my research findings and recommendations with you. The committee has taken up the issue of broadening diversity in STEM fields in an era of urgent need to improve the nation's infrastructure, environmental sustainability, security, and manufacturing. Currently we are experiencing a loss of talent from STEM, as each year African American, Latina and Latino, and American Indian students start their college studies as STEM majors, but then leave those fields at high rates. The National Science Foundation's (NSF) role in addressing these problems is under review. You have asked me to address, in particular, the challenges of increasing the participation of Hispanic students in STEM fields.

In this testimony, I first describe the context of higher education for Hispanic students, who attend community colleges and Hispanic Serving Institutions (HSIs) more than other students. I then discuss the value of NSF funding in two broad categories: (1) student services, academic support programs, and curricular reform; and (2) scholarships and fellowships. While recognizing the value of expanded student services and academic programming, I raise concerns that current approaches do not address the fundamental problem of the negative racial climate in STEM classrooms and programs. In conclusion, my recommendations emphasize the need for consortium based and interdisciplinary collaboration in curriculum reform, particularly in mathematics education. I also call for the adoption of more robust and comprehensive evaluation standards to evaluate the impact of NSF funding on diversity in STEM.

In making these recommendations, I draw on findings from a three-year NSF-funded study (STEP–Type 2) called *Pathways to STEM Bachelor's and Graduate Degrees for Hispanic Students and the Role of Hispanic Serving Institutions,* for which I serve as principal investigator. This study involved statistical analyses of college financing strategies and the impact of debt on graduate school enrollment; interviews with ninety faculty, administrators, and counselors at Hispanic Serving Institutions; and the development of instruments to assess institutional capacity for expanding Hispanic student participation in STEM. I also draw on my experiences as an educational researcher and methodologist, a review panel member for research proposals submitted to the NSF and the Institute for Education Sciences (TES), and as co-director of the Center for Urban Education (CUE) at the University of Southern California. CUE's mission is to conduct socially conscious research and develop the tools needed by institutions of higher education to produce equity in student outcomes.

Hispanic Students in Higher Education and STEM[1]

Two types of institutions play a much greater role in the education of Hispanic students in comparison to students of other racial-ethnic groups: community colleges and Hispanic Serving Institutions (HSIs,) which are defined by the Federal Government as institutions with 25% or more Hispanic full-time equivalent student enrollment. More than half of all Hispanic college students enrolled in post-secondary education attend a community college. In 2006, the enrollment of Hispanic students in U.S. community colleges was 932,526, which compares with 903,079 Hispanic students enrolled in four-year institutions. Hispanic college students are enrolled in HSIs in such large numbers that approximately half of all Latina and Latino undergraduates enrolled in four-year universities can be found at just a fraction (10%) of four-year universities. As a result, a large proportion (40%) of the bachelor's degrees awarded to Hispanic students in all fields of study are awarded by HSIs.

In 2006–07, 265 institutions of higher education were classified as Hispanic Serving Institutions (HSIs). Almost half of these were community colleges. The other half were divided between public and private not-for profit four-year universities (with a small number of private not-for profit two-year institutions). Hispanic students and Hispanic Serving Institutions are heavily concentrated in the Southwestern states, where over half of the HSIs are located (see Figure 1). However, several states outside the Southwest are also home to HSIs, including Florida, Illinois,

[1] For further information, data sources, and references, see *Benchmarking the Success of Latina and Latino Students in STEM to Achieve National Graduation Goals* by Alicia C. Dowd, Lindsey E. Malcom, and Estela Mara Bensimon (December, 2009, USC Center for Urban Education) and *Improving Transfer Access to STEM Bachelor's Degrees at Hispanic Serving Institutions through the America COMPETES Act* by Alicia C. Dowd, Lindsey E. Malcom, and Elsa E. Macias (forthcoming March 2010, USC Center for Urban Education).

and New York, and fifty-one HSIs are located in Puerto Rico. More institutions will be classified as HSIs in other states as the Hispanic population continues to grow.

Although approximately 40% of the bachelor's degrees awarded to Hispanic students in all fields of study are awarded by HSIs, this proportion is lower in STEM fields. Only 20% of the bachelor's degrees awarded to Hispanic students in STEM fields are awarded by HSIs. Only a small percentage of Hispanic STEM baccalaureates (6.5%) earn the bachelor's degree at an HSI after having earned an associate's degree.

In her analysis of NSF's National Survey of Recent College Graduates (NSRCG)[2] for our study of Latino Pathways to STEM Degrees, Professor Lindsey Malcom of the University of California Riverside found that Latino community college transfers who first earn associate's degrees have lower access to STEM bachelor's degrees at academically selective and private universities than their counterparts who do not earn an associate's degree prior to the bachelor's. These transfer students who held associate's degrees were more likely to graduate from Hispanic Serving Institutions (32.1% with an associate's degree compared to 16.8% without one) and from public four-year institutions (83% as opposed to 62.9%). However, they were less likely to graduate from academically selective institutions (42% with an associate's degree compared to 59% without one) or from a research university (25.3% as opposed to 43.5%).

The analysis also showed differences in the fields of study in which students earned their bachelor's degrees. HSIs had greater success than non-HSIs in graduating Latinos in several STEM fields of critical importance in the workforce, particularly computer science and mathematics. However, transfer students who first earned associate's degrees were less likely to earn degrees in those fields of study at HSIs.

These figures would change if we used a different definition of transfer students (for example those who transferred after the equivalent of one year of study, or 30 credits), but they illustrate that certain pathways to STEM bachelor's degrees are not as readily accessible for students who start out in community colleges. Notably, those institutions that provide the greatest access to graduate degrees (academically selective and research universities) are least accessible to Latina and Latinos who earn associate's degrees. As a result, the proportion of STEM doctoral degrees awarded to Hispanic students (estimated at less than. 5%) severely lags the proportion of Hispanics in the U.S. population (around 15%). Our study indicates that access to STEM bachelor's and graduate professions can be expanded for Hispanic students by improving access to STEM bachelor's and graduate degrees through transfer from community colleges.

Expanded transfer access is necessary because although Hispanic participation in STEM fields has risen, it has not kept pace with Hispanic population growth. Growth in the number of bachelor's degrees awarded to Hispanic students has occurred primarily in non-science and engineering fields. From 1998 to 2007, there was a 64% increase in the number of non-science and engineering bachelor's degrees awarded to Hispanic students, as compared to an increase of only 50% in science and engineering degrees awarded to Hispanic students.

Furthermore, most of that 50% growth occurred primarily in the social sciences and psychology rather than in the biological sciences, engineering, computer sciences, and other fields categorized as STEM fields. The lower participation of Hispanic students in STEM is not due to lack of interest. A recent report by UCLA's Higher Education Research Institute demonstrates that Hispanic students enter college with the same aspirations to earn STEM degrees as students of other racial-ethnic backgrounds.[3]

Although the number of STEM bachelor's degrees awarded to Hispanic students grew over the past decade, the rate of growth in the number of STEM degrees awarded at other levels (associate's, master's and doctoral) was quite flat. Approximately 6,000 associate's degrees were awarded to Hispanics in science and engineering fields in 2007, a relatively low number given the large population of Hispanics enrolled in community colleges. These figures reflect the fact that many community college students from all racial-ethnic groups are placed in remedial mathematics classes at community colleges. There is considerable variation by state, but it is not uncommon for the rate of remedial placement to be as high as 50% at community

[2] For details, see Malcom, L. E. (2008). *Accumulating (dis)Advantage? Institutional and financial aid pathways of Latino STEM baccalaureates.* Unpublished dissertation, University of Southern California, Los Angeles. CA.

[3] Hurtado, S., Pryor, J., Trail, S., Blake, L.P., DeAngelo, L., & Aragon, M. (2010). *Degrees of Success: Bachelor's Degree Completion Rates among Initial STEM Majors.* Los Angeles, CA: Higher Education Research Institute, UCLA.

colleges and in some colleges that figure can reach as high as 90%. Remedial instruction in mathematics is also common at the four-year level, but the rates of remedial placement are lower, nearer to 20% or 30%. Improving teaching and learning in mathematics instruction is therefore a high priority for increasing the numbers of STEM degrees awarded to Hispanic students.

National Science Foundation (NSF) Support for Diversity in STEM

Student Services, Academic Support Programs, and Curricular Reform

NSF currently funds special programs at community colleges and four-year institutions that aim to increase the number of students earning STEM degrees by providing enhanced student services and academic advising. Typical strategies focus on recruitment, orientation, faculty and peer mentoring, and intrusive advising to inform students if they are running into trouble academically or to guide them in making good academic choices. These strategies are primarily designed to reduce the difficulties of navigating college by providing students with information and extra support. Other programs go farther by offering learning experiences designed to better engage students in scientific study, such as through intensive summer research programs, learning communities, and supplemental instruction. A subset of the student services and academic support programs place a particular emphasis on increasing the numbers of students from underrepresented racial-ethnic groups in STEM.

The value of these special programs is supported by research that indicates such approaches are "best practices" for keeping students in college. However, the most common program designs implemented by NSF grantees are not informed by studies of the racial climate of STEM classrooms and programs. Recent research documents that racial stigma and discrimination create significant barriers to the participation of underrepresented racial-ethnic groups in STEM. A sampling of recent studies and reports illustrates this point:

- A literature review issued in 2009 documenting the "Talent Crisis in Science and Engineering" points to "traditions and stereotypes" that create low expectations, bias, and race discrimination as a primary cause of the loss of talent in STEM fields.[4]
- A book published in 2009 titled "Standing on the Outside Looking In: Underrepresented Students' Experiences in Advanced Degree Programs" captures the experiences of African American, Latina, and Latino graduate students of color. It documents hostile learning environments and experiences of marginalization and exclusion based on race and ethnicity, class, gender, and language among students of color in STEM fields and Latinas in doctoral and professional programs in the health sciences.[5]
- A report issued in 2010 on "Diversifying the STEM Pipeline: The Model Replication Institutions Program" raises concern about the lack of "buy in" among faculty and senior leadership at participating campuses towards the goal of increasing access and success in STEM education for minority and low-income students.[6]
- A research article published in 2009 emphasizes that African American students participate in mathematics education with an acute awareness of the dynamics of race and racism in their lives. Successful students embrace a mathematics identity and an identity as African Americans, but this often comes only through a great deal of struggle and perseverance.[7]

Programs that do not address the fundamental problem of the negative racial climate in STEM fields are, therefore, unlikely to have a substantial impact to increase diversity.

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[4] Sevo, R. (2009). The talent crisis in science and engineering. Retrieved February 1, 2009, from SWE–AWE: *http://www.engr.psu.edu/AWE/ARPResources.aspx*

[5] Gasman, M., Perna, L. W., Yoon, S., Drezner, N. D., Lundy-Wagner, V:, Bose, E., et at. (2009). The path to graduate school in science and engineering for underrepresented students of color (pp. 63–81) and Gonzalez, J. C. (2009) Latinas in doctoral and professional programs: Similarities and differences in support systems and challenges. In M. F. Howard-Hamilton, C. L. Morelon-Quainoo, S. M. Johnson, R. Winkle-Wagner & L. Santiague (Eds.), *Standing on the outside looking in: Underrepresented students' experiences in advanced degree programs* (pp. 103–123).

[6] *Diversifying the STEMpipeline: the Model Replication Institutions Program* (n.d.). Washington, D.C.: Institute for Higher Education Policy (IHEP).

[7] Martin, D. B. (2009). Researching race in mathematics. *Teachers College Record, 111*(2), 295–338.

There is a second problem that limits the potential of such interventions. They are not primarily designed to transform STEM education at its heart: in the classroom and the core curriculum. They tend to be program based and therefore seldom bridge the boundaries of different disciplines and types of institutions. There is a risk that the improvements in mentoring, advising, supplemental instruction, and laboratory instruction that may be brought about by the special programs that have been funded will remain on the periphery and not have a broader impact on STEM education.

Through the case study component of the USC Center for Urban Education's (CUE) study of Latino Pathways to STEM Degrees, researchers under the leadership of Professor Estela Mara Bensimon, co-director of CUE and co-principal investigator of this NSF-funded study, interviewed ninety faculty, administrators, and counselors at three universities and three community colleges, all of which were Hispanic Serving Institutions. Many of these individuals were employed by or affiliated with NSF-funded programs designed to improve diversity in STEM fields. These respondents often described and shared data with us showing programs intensively focused on a small number of Hispanic students relative to the entire Hispanic student body. As often as not, those we interviewed worked in isolation and were not part of robust networks of faculty and administrators engaged in changing the STEM curriculum. For some the isolated nature of the work led to a sense that the goal of improving Hispanic student participation and degree completion in STEM fields was not supported by the college leadership. These results led us to question whether interventions through special programs can be adequate to the task of substantially increasing the number of Hispanic students being awarded STEM degrees.

This committee has already heard testimony on February 4, 2010 from Dean Karen Klomparens of Michigan State University and Professor Robert Mathieu of the University of Wisconsin at Madison regarding the importance of creating active learning in STEM education and providing faculty with the know-how (through professional development) to bring about active learning. I endorse their testimony and note that in regard to diversity issues in STEM, active learning and "real world" problem-solving approaches hold promise to reduce the sense of alienation of underrepresented racial-ethnic groups too often experience in STEM fields. Studies show that students of color value the opportunity to serve communities and address social problems through their college coursework.

However, as important as active learning and real world problem solving is, even this solution is not sufficient in and of itself to substantially improve diversity in STEM fields. Active learning can be incorporated without attention to the root problem of the racial discrimination, stigma, and alienation experienced by underrepresented students in STEM fields. NSF has played an important role in supporting experimentation in the STEM curriculum. Future funding will be valuably invested by ensuring that curricular innovation and reform occurs in the core curriculum and with the majority of faculty members involved. Such initiatives will also need to directly engage and be designed to tackle the problems of racial discrimination experienced by too many students who then depart STEM.

Scholarships and Fellowships

Current NSF funding invests considerably in research and graduate fellowships for undergraduate and graduate students, including students from underrepresented racial-ethnic groups, in STEM fields. Many studies indicate that targeted financial aid is extremely important and that grants of this type improve students' persistence and degree completion in college. Scholarships and fellowships also reduce students' need to borrow for post-secondary education at the undergraduate and graduate level.

This is of particular importance when we consider diversity in STEM because debt can have a more negative impact on underrepresented students. An analysis by Professor Lindsey Malcom of the University of California Riverside of NSF's National Survey of Recent College Graduates (NSRCG), conducted as part of the CUE's study of Hispanic student pathways to STEM degrees, found that cumulative undergraduate debt among STEM bachelor's degree holders (measured in relative telius in comparison with the typical amount of debt at the graduate's institution) had a more negative effect on graduate school enrollment right after college among Hispanic STEM baccalaureates than among students of other racial-ethnic backgrounds. We do not interpret these findings as a sign of risk aversion among Hispanic students, as some analysts have inferred, because the Hispanic STEM bachelor's degree holders in the study tended to have a higher amount of debt than the typical graduate in their graduating class. The findings suggest a reluctance to incur more debt for graduate or professional study, which is a typical financing pattern except for those students who receive graduate fellowships. They illustrate the importance of scholarships and fellowships in improving Hispanic student participation in STEM fields and professions. They also provide support for policies that offer student loan forgiveness to students who work in socially valued professions such as mathematics education and clinical health care.

Recommendations

Summary

Through NSF funding, we have made valuable investments in the development of student services and academic support programs to help students navigate the complexities of college and the STEM curriculum. However, a broader strategy is required to reduce the negative campus climates experienced by Hispanic students and other racial-ethnic minorities. This is because stereotypes of underrepresented students—representing them as unable to succeed or disinterested in STEM—are pervasive in society, schools, and post-secondary education. The "treatment" of special programs in relation to the overall problem is insufficient because they tend to take place at the margins rather than the core of higher education.

This is not to say that special advising and student services programs are not part of the necessary remedy—they are. The work in this area has identified workable strategies for providing students with additional information, support, and direction. However, the next generation of studies and experimental programs must explore models of even more fundamental organizational change in terms of curriculum design, assessment of student learning, and faculty and administrator rewards.

Areas for Future NSF Support

The area in greatest need of pedagogical innovation is remedial and basic skills mathematics instruction. Community college students in particular must experience success in mathematics to gain the competencies needed to earn degrees in biological, agricultural and environmental sciences, and in engineering, which are fields with limited transfer access for transfer students who earn their bachelor's degrees at HSIs.

To encourage diversity and active learning in STEM, we must invest in bold experiments in curriculum and pedagogical reform that are informed by the principles of culturally responsive pedagogy. Priority should be given to initiatives that include a focus on integrating mathematics education in real world problem solving. These experiments should involve people from multiple scientific, social science, and educational research disciplines. As well as being interdisciplinary, they should be "intersectoral," bringing faculty, administrators and counselors from different types of institutions into close collaboration. **Consortia involving community colleges, four-year comprehensive institutions, and research universities in regional service areas are needed to improve transfer access for Hispanic students from community colleges to STEM bachelor's and graduate degrees.**

Few observers of American politics and society would disagree that racial issues are among the thorniest in the U.S. Yet, to broaden participation among racial-ethnic groups underrepresented in STEM requires attention to the underlying racial dynamics of STEM education. We cannot fix problems of diversity without acknowledging the problems of racial marginalization and stigma and stating the intent to fix them. Toward that end, a body of research knowledge has emerged that provides concrete and practical steps faculty can take to introduce culturally responsive pedagogies in classrooms and other instructional settings.

A powerful tool for shaping the objectives and methods adopted by recipients of NSF funds is the Program Solicitation (or request for proposals.) A valuable first step in broadening participation in STEM fields would be to convene a panel of experts in culturally responsive pedagogy alongside scientists and social scientists to develop the language for a program solicitation. Their charge would be to write **a Program Solicitation that makes the study of the racial dynamics of instructional environments in STEM a central component of curriculum and pedagogical reform.**

The criteria for award decisions should also support the mission focus of proposals from HSIs that propose specifically to develop the Hispanic serving capacity of their institution (and similarly the mission focus of historically black colleges and universities and tribal colleges). This can be indicated by staffing, hiring, professional development, and evaluation criteria that involve a critical mass of Hispanic faculty and administrators in program implementation and a large proportion of Hispanic students on a campus (or located in institutional service areas) in program participation.

Evaluation

Campuses will be able to achieve more widespread involvement in STEM reform by engaging STEM faculty at the department and college levels in self-assessment of their educational practices and beliefs regarding the causes of student success and lack of success. Reflective practices are needed to comprehend the complexities underlying student experiences of racial stigma and discrimination.

The methods of benchmarking can be used to create a more comprehensive evaluation system that measures program effectiveness and cost-effectiveness, student outcomes, faculty development, and changes in organizational policies. There are three valuable strategies, which are called performance, diagnostic, and process benchmarking.[8] Each has a different application and can be used together for a more robust measurement and implementation design:

- **Performance benchmarking** is used to establish baseline performance and to set and evaluate progress towards improvements in student transfer and degree completion.
    - Data collected at the program proposal stage should demonstrate the capacity to observe the progress of cohorts of students at key curricular milestones and transitions and to disaggregate data by racial-ethnic groups.
    - Data collected for program evaluation should compare the progress of students enrolled in the program or affected by the initiative in comparison to a group that was not involved.
- **Diagnostic benchmarking** involves assessing one's own campuses practices against established standards of effective practice, as documented in the research and professional literature.
    - The principles of culturally responsive pedagogy provide standards for diagnostic benchmarking for curriculum and instruction.
    - The sociological concept of "institutional agents," as developed by the sociologist Ricardo Stanton Salazar[9] and applied in the context of STEM post-secondary education in collaboration with researchers at the Center for Urban Education, provides diagnostic standards for administration, counseling, and mentoring specifically designed to provide support to students from racial-ethnic minority groups.
- **Process benchmarking** involves closely investigating the changes in organizational policies, procedures, and practices that are needed to implement effective practices in a particular campus context with fidelity.
    - Self assessment instruments have been developed by the Center for Urban Education[10] and other organizations to assist campuses in observing the racial-ethnic dimensions of instructional and administrative practices. The outcome of process benchmarking is data-informed decision making for ensuring program effectiveness.
    - **Process benchmarking is particularly valuable when it is carried out within consortia where trust develops over time so that participating campuses become willing to share their data and engage collaborators in problem solving.** Strategies that are effective at one campus may not work at all on another because of differences in resources, personnel, and institutional culture, so the capacity for data-informed problem solving is necessary.

Campuses will benefit from resources to develop their evaluation capacity prior to implementing large-scale programmatic or curricular reform. One valuable way to acquire this capacity is by serving as a peer evaluator to a partnering institution in a peer group.

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[8] For further information, see Dowd, A. C., & Tong, V. P. (2007). Accountability, assessment, and the scholarship of "best practice." In J. C. Smart (Ed.), *Handbook of Higher Education* (Vol. 22, pp. 57–119): Springer Publishing.

[9] Stanton-Salazar, R. D. (2001). *Manufacturing hope and despair: the school and kin support networks of U.S.-Mexican youth.* New York: Teachers College Press.

[10] See Bensimon, E. M., Polkinghome, D. E., Bauman, G. L., & Vallejo, E. (2004). Doing research that makes a difference. *Journal of Higher Education, 75*(1), 104–126; and Dowd, A. C. (2008). The community college as gateway and gatekeeper: Moving beyond the access "saga" to outcome equity. Harvard Educational Review, 77(4), 407–419.

By using these three types of benchmarking procedures, campuses can evaluate instructional effectiveness in producing greater diversity in STEM and increasing the number of Hispanic students who are awarded STEM degrees. In sum, these are strategies for organizational learning, professional development, and pedagogical innovation. **For too long, our approach to improving diversity in STEM has been overly focused on the "demand" side of the problem, on "fixing" presumed student deficits through attempts to improve their aspirations, motivation, or willingness to succeed. In contrast, these recommendations focus on fixing the "supply" side of the problem by improving the quality of STEM education.** Research conducted at the Center for Urban Education demonstrates that the most important starting point for broadening participation in STEM is to reframe the lack of diversity as problems of institutional practices and practitioner knowledge,[11] which unwittingly create a negative racial climate harmful to students from racial-ethnic minority groups.

Figure 1 Hispanic Serving Institutions by State, 2006-2007

[11] See Bensimon, E. M. (2007). The underestimated significance of practitioner knowledge in the scholarship of student success. *The Review of Higher Education, 30*(4), 441–469; and Bensimon, E. M., Rueda, R., Dowd, A. C., & Harris III, F. (2007). Accountability, equity, and practitioner learning and change. *Metropolitan, 18*(3), 28–45.

BIOGRAPHY FOR ALICIA C. DOWD

Alicia C. Dowd, Ph.D., is an associate professor of higher education at the University of Southern California's Rossier School of Education and co-director of the Center for Urban Education (CUE). Dr. Dowd's research focuses on political-economic issues of racial-ethnic equity in post-secondary outcomes, organizational learning and effectiveness, accountability and the factors affecting student attainment in higher education.

Dr. Dowd is the principal investigator of a National Science Foundation funded study of *Pathways to STEM Bachelor's and Graduate Degrees for Hispanic* Students and the Role of Hispanic Serving Institutions. Through this study, CUE is examining the features of exemplary STEM policies and programs to identify ways for institutions—both Hispanic Serving Institutions (HSls) as designated by the U.S. Department of Education, and non-Hispanic Serving—to increase the number of Latino STEM graduates.

Dr. Dowd has served as the principal investigator of several major, national studies of institutional effectiveness, equity, community college transfer, benchmarking, and assessment. The results of these studies have been published in numerous journals including the *Review of Educational Research, the Harvard Educational Review, the Journal of Higher Education, the Review of Higher Education, Research in Higher Education, and Teacher's College Record.*

As a research methodologist, Dr. Dowd has also served on numerous Federal evaluation and review panels, including the Education Systems and Broad Reform Panel and the National Education Research and Development Center panels of the institute for Education Sciences (IES) and NSF's Science, Technology, Engineering, and Mathematics Talent Expansion Program (STEP-Type 2) review panel. She was also a member of the technical working group consulting on the evaluation design for the Academic Competitiveness and SMART (science, mathematics, technology) grants awarded by the U.S. Department of Education. Currently she is a member of the advisory group for the Congressional Advisory Committee on Student Financial Aid (ACSFA).

Dr. Dowd was awarded the doctorate by Cornell University, where she studied the economics and social foundations of education, labor economics, and curriculum and instruction. Her undergraduate studies were also at Cornell, where she was awarded a bachelor of arts degree in English literature.

Ms. FUDGE. Thank you.

Dr. Stassun.

STATEMENT OF DR. KEIVAN G. STASSUN, ASSOCIATE PROFESSOR OF PHYSICS AND ASTRONOMY, VANDERBILT UNIVERSITY, AND CO-DIRECTOR OF THE FISK–VANDERBILT MASTER'S-TO-PH.D. BRIDGE PROGRAM

Dr. STASSUN. Congresswoman Fudge, Ranking Member Ehlers, a fellow physicist, I might add, and members of the Subcommittee, I am Keivan Stassun, Associate Professor of Astronomy at Vanderbilt University and Adjunct Professor of Physics at Fisk University as well as Co-Director of the Fisk-Vanderbilt Master's-to-Ph.D. Bridge Program. I would like to focus my remarks this morning on the need for more American citizens earning Ph.D.s in STEM fields, and the role of the Federal Government in furthering that goal.

Madam Chairwoman, it is in the Nation's interests to sustain a vital pipeline of Americans earning doctoral degrees in STEM fields. These Ph.D.s represent our national brain trust in science and engineering. They are the leaders of our world-class laboratories, the principal investigators of Federal R&D initiatives, the teachers and role models for subsequent generations of America's explorers. It matters that these future STEM leaders reflect the face of America.

Yet today, as you heard from Dr. Malcom, less than half of all STEM Ph.D.s awarded in the United States go to citizens of the United States, and U.S. citizens who are underrepresented minorities comprise only four percent of all STEM Ph.D.s awarded by U.S. institutions. We are very effectively training the STEM leaders for the rest of the world. One consequence is that we have few American minorities on the STEM faculty at major research universities. Even with an immediate five-fold increase in the production of minority STEM Ph.D.s, we will not achieve parity relative to the U.S. population for another 30 years. This is no time for gradualism.

It is with this imperative that the Fisk-Vanderbilt Master's-to-Ph.D. Bridge Program was initiated six years ago as a STEM faculty-led collaboration between Fisk, a venerated Historically Black University, and Vanderbilt, a major research university, both in Nashville, Tennessee. Since then, Fisk has become one of the top ten producers of physics master's degrees among all U.S. citizens, and no institution awards more master's degrees in physics to black U.S. citizens. In 2009, just five years after its inception, the Fisk-Vanderbilt bridge program graduated its first Ph.D. Overall, the program's retention rate is 92 percent and Vanderbilt is on track to award between five and ten times the number of minority Ph.D.s in physical sciences as our peer institutions. Our most recent cohort alone represents a 100 percent increase in the national production of minority Ph.D. astrophysicists.

One of our key strategies is to actively scout out American students with unrealized potential for STEM careers. This idea of scouting talent for our laboratories the way we do for athletic teams represents a departure from 'business as usual' for Vanderbilt, which, like most universities, has traditionally relied on metrics such as GRE scores to rank its Ph.D. applicants. But in the globalized 21st century, American students are simply being outperformed on these metrics by their peers from China, India and other nations who apply to our laboratories in large numbers.

In the Fisk-Vanderbilt program, we get to really know our students. By completing a two-year master's degree at Fisk under the mentorship of Fisk and Vanderbilt faculty, the students have a chance to show what they are made of, excelling in our tough graduate courses, making discoveries in our laboratories and demonstrating the traits we seek in promising young students: creativity, entrepreneurial spirit, grit. These are the traits that distinguish American students from their peers around the world and which will always be at the heart of our global leadership and competitiveness.

But the bottom line is that faculty leaders dedicated to diversity in STEM are the single-most important ingredient in our success. The intensive one-on-one student mentoring that is so central to the Fisk-Vanderbilt model depends absolutely on faculty who already shoulder extensive demands in the form of teaching, managing world-class laboratories and producing tangible returns on Federal R&D investment. We do it because we view diversity in STEM as a national priority for reasons that are at once strategic, moral, competitive, even patriotic.

STEM faculty are also entrepreneurial people who respond to Federal incentives in R&D funding. A promising example is the NSF Career Awards. These are among the most prestigious grants that a STEM faculty can receive, requiring both cutting-edge research and what NSF calls 'broader impact', which explicitly includes broadening participation as a goal. NSF Career Awards, to several of us at Vanderbilt, have been instrumental in launching our careers, helping us to secure tenure and catalyzing the Fisk-Vanderbilt Bridge Program's success.

Authorizing other Federal agencies such as NASA and DOE to adopt NSF'S broader impacts language or something like it would be a powerful way for Congress to incentivize and reward the STEM faculty and other researchers who lead the Nation's broadening participation charge.

Mr. Chairman, thank you for the opportunity to testify today. I would be happy to answer any questions from the Subcommittee.

[The prepared statement of Dr. Stassun follows:]

PREPARED STATEMENT OF KEIVAN G. STASSUN

ASSOCIATE PROFESSOR OF ASTRONOMY, VANDERBILT UNIVERSITY [1]

ADJUNCT PROFESSOR OF PHYSICS, FISK UNIVERSITY [2]

CO-DIRECTOR, FISK-VANDERBILT MASTER'S-TO-PH.D. BRIDGE PROGRAM

DIRECTOR, VANDERBILT INITIATIVE IN DATA-INTENSIVE ASTROPHYSICS (VIDA)

Chairman Lipinski, Ranking Member Ehlers, Members of the Subcommittee, I am Keivan Stassun, associate professor of astronomy at Vanderbilt University, adjunct professor of physics at Fisk University, and co-director of the Fisk-Vanderbilt Master's-to-Ph.D. Bridge Program. Thank you for inviting me to testify before you today. It is a privilege and an honor to tell you about the Fisk-Vanderbilt Master's-to-Ph.D. Bridge program specifically and my thoughts on broadening participation in STEM fields more generally.

The Fisk-Vanderbilt Master's-to-Ph.D. Bridge Program [3]

(additional comments and supporting material in Appendix A):

By completing a Master's degree at Fisk under the guidance of caring faculty mentors, students develop the strong academic foundation, research skills, and one-on-one mentoring relationships that will foster a successful transition to the Ph.D. at Vanderbilt. The program is flexible and individualized to the goals and needs of each student. Courses are selected to address gaps in undergraduate preparation,

[1] Department of Physics & Astronomy, VU Station B 1807, Nashville, Tennessee, 37235
[2] Department of Physics, 1000 17th, Ave. N., Nashville, Tennessee, 37208
[3] *http://www.vanderbilt.edu/gradschool/bridge*

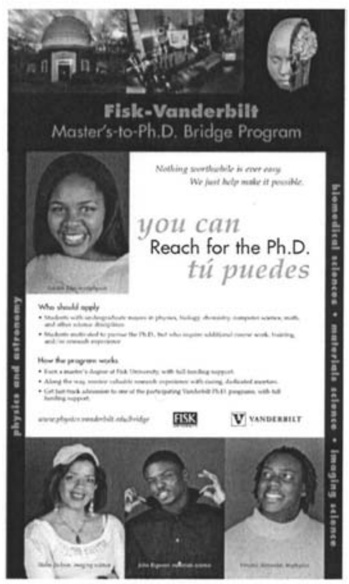
and research experiences are provided that allow students to develop—and to demonstrate—their full scientific talent and potential.

The Fisk-Vanderbilt Master's-to-Ph.D. Bridge Program is intended for:

- Students who have completed baccalaureate degrees in physics, chemistry, biology, or engineering.
- Students motivated to pursue the Ph.D. but who require additional coursework, training, and/or research experience.

How the program works, in a nutshell:

- Earn a Master's degree in physics, chemistry, or biology at Fisk, with full funding support.
- Along the way, get valuable research experience with caring, dedicated mentors. Emerge with the solid preparation for entry into a world-class Ph.D. program, and the ongoing support of a network of dedicated mentors.
- Get fast-track admission to a participating Vanderbilt Ph.D. program, with full funding. Participating Ph.D. programs at Vanderbilt currently include: astronomy, physics, materials science, biology, and biomedical sciences.



Key milestones achieved by the Fisk-Vanderbilt Master's-to-Ph.D. Bridge Program include:

- Since 2004, the program has attracted 35 students, 32 of them underrepresented minorities[4] (URMs), 59 percent female, and a retention rate of 92 percent (see Appendix A).
- The first Bridge Program Ph.D. was awarded (in materials science) in 2009, just five years after the program's inception.[5]
- The Bridge program is on track to award ten times the U.S. institutional average number of URM Ph.D.s in astronomy, nine times the average in materials science, five times the average in physics, and two times the average in biology (the biology track was newly added in 2008). The most recent incoming cohort alone includes more URB students in astronomy than the current annual production of URM Ph.D. astronomers for the entire U.S.

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[4] Underrepresented minorities (URMs) are defined as U.S. citizens and permanent residents who are of African-American, Hispanic, or Native American descent.

[5] Read an article about the first Fisk-Vanderbilt Bridge Program Ph.D. recipient: *http://sitemason.vanderbilt.edu/vanderbiltview/articles/2010/02/26/crossing-the-bridge.108290*

- Bridge students have been awarded the nation's top graduate fellowships from NSF and NASA.
- In 2011, Vanderbilt will achieve the distinction of becoming the top research university to award Ph.D.s to URMs in astronomy, physics, and materials science.
- Already, as of 2006, no U.S. institution awards more Master's degrees in physics to Black U.S. citizens than Fisk. Fisk has also become one of the top 10 U.S. institutions awarding the Master's degree in physics to U.S. citizens of all ethnic backgrounds [data source: American Institute of Physics].
- Extramural grants from NSF and NASA—supporting Bridge graduate students, faculty, and related undergraduate research—now exceed $25M.

The Fisk-Vanderbilt Master's-to-Ph.D. Bridge Program started in 2004 with one student in each of astronomy, physics, and materials science. Catalyzing elements for initiating the program included the following:

- An NSF CAREER award to Prof. Keivan Stassun, which included collaborative research between Vanderbilt and Fisk faculty and students, with a major goal of training URM Ph.D.s in astronomy as a centerpiece of the "broader impacts" component of the award.
- A NASA MUCERPI grant jointly to Fisk and Vanderbilt, centered on collaborative research between Fisk and Vanderbilt faculty and students, with a major goal of training URM Ph.D.s in NASA-related STEM disciplines.
- An NSF IGERT grant jointly to Vanderbilt and Fisk, centered on collaborative research between Vanderbilt and Fisk faculty and students, with a major goal of training URM Ph.D.s in materials science.
- Supportive administrators at both universities committing significant institutional funds as match to the above grants (e.g. tuition waivers), and directives permitting cooperation of the university bureaucracies, including course cross-registration and reciprocal access to university resources (e.g., research facilities, libraries, student services).

Soon after the program's inception, it was recognized that the "bridge" from Fisk to Vanderbilt needed to be formalized in order to establish clear guidelines by which a student successfully "crosses the bridge" and to ensure clear lines of responsibility, accountability, and support Specifically:

- Each of the disciplinary "tracks" with the Bridge program (astronomy, physics, materials science) has *concrete requirements for students to successfully make the transition from the Fisk master's degree program to the Vanderbilt Ph.D. program,* including specific graduate level courses that must be passed and specific requirements for research performance. These guidelines are approved by the respective deans at both universities.
- *Two program co-directors, one each at Fisk and Vanderbilt, have been formally appointed by the provosts of both universities.* These co-directors have official responsibility for administration of the Bridge program and are directly accountable to the provosts of the two universities.
- *A program Steering Committee* was established, with faculty leaders at both universities in each of the disciplinary tracks. These faculty leaders provide oversight, guidance, and tracking of student progress.
- *A formal mentoring structure* is in place, providing each Bridge student with "scaffolds of support" that help to ensure a successful transition across the bridge. This includes: (i) assignment of two faculty co-mentors, one from Fisk and one from Vanderbilt, for each student; (ii) a monthly "professional development seminar" aimed at demystifying the process of reaching the Ph.D. for these students who, almost without exception, are the first-generation in their families to pursue higher education; (iii) a peer-to-peer mentoring structure allowing more senior Bridge students to help guide and counsel the students crossing the bridge behind them in a spirit of camaraderie; (iv) development of a "mentoring management console" for careful tracking of individual student progress, enabling Bridge faculty to identify potential problem cases early and to intervene quickly with additional support/resources as needed to prevent students from slipping through the cracks; and (v) dedicated administrative support staff (program coordinators) at both universities, providing an additional layer of mentoring support and a one-stop go-to person on each campus to help students solve bureaucratic/logistical problems that may arise.

In 2007, the Bridge program began to identify additional disciplinary tracks that could be introduced in order to expand the program's scale and impact. In addition, the Bridge program has begun to partner with additional institutions in order to (i) better connect Bridge students with mentors and cutting-edge research opportunities in the broad array of areas of interest to the students, and (ii) increase the pool of quality students whom we could recruit to our program.

- So far, a biology track has been added and formalized, including assignment of faculty leaders in biology. A new track in chemistry is under development.
- Several junior faculty leaders involved in the expansion of the Bridge program have now received prestigious NSF CAREER awards, including: Prof. Shane Hutson (biophysics), Prof. Eva Harth (chemistry), Prof. Kelly Holley-Bockelmann (astrophysics).
- Core partners now include: Boston University, Massachusetts Institute of Technology, National Optical Astronomy Observatories, National Solar Observatory, NASA Goddard Space Flight Center, Delaware State University, and University of Hawaii at Hilo.

There are two major characteristics of the Fisk-Vanderbilt Master's-to-Ph.D. Bridge Program that we believe are central to its successes:

1. The Bridge program's basic design and structure—a "bridge" from the master's degree at an HBCU to the Ph.D. at a major research university—is grounded in research on the educational pathways that URMs in STEM follow en route to the Ph.D. In particular:

    a. *Minority Serving Institutions*[6] *(MSIs) represent large—and largely untapped—pools of URM talent in STEM.* For example, the top 15 producers of African American physics baccalaureates in the U.S. are all HBCUs, and just 20 HBCUs were responsible for producing fully 55 percent of all African American physics baccalaureates in the U.S. between 1998 and 2007.[7] Moreover, these institutions are successful at placing students in Ph.D. programs. Among the U.S. baccalaureate-origin institutions of African American STEM Ph.D. recipients for the years 1997–2006, the top 8, and 20 of the top 50, were HBCUs[8] (see Appendix A).

    b. *URMs who earn Ph.D.s in STEM fields are about 50 percent more likely than their non-URM counterparts to have earned a "terminal" master's degree (i.e. not a master's degree earned as part of a Ph.D. program.*[9] before eventually transitioning to a Ph.D. programs. The number of MSIs with research-active faculty, and that offer advanced STEM degrees, has undergone dramatic growth. For example, the number of MSIs offering Master's degrees in the physical sciences or engineering has increased over the past decade by 79 percent, and the number of URMs earning Master's degrees from these institutions increased correspondingly by 533 percent (see Appendix A).

2. Because of the critical nature of the master's-to-Ph.D. transition, at the heart of the Bridge program's model is the concept of *facilitating a successful transition to the Ph.D.* In collaboration with researchers at the Columbia University School of Law, we have identified the following four key components that are critical to facilitating a successful transition to the Ph.D., and that are deliberately put into practice by the Bridge program:

    a. *Build and sustain research-based partnerships between Fisk and Vanderbilt faculty.* Joint research is the engine of institutional collaboration, the basis for extramural funding, and provides a concrete "performance-based metric" by which to assess student ability and promise for a research based Ph.D.

[6] MSIs include Historically Black Colleges and Universities (HBCUs), Hispanic Serving Institutions (HSIs), and Tribal Colleges and Universities (ICUs), as defined by the U.S. Department of Education.

[7] AIP Statistical Research Center, Enrollment and Degrees Survey.

[8] Burrelli, J., & Rapoport, A. 2008, "Role of HBCUs as Baccalaureate-Origin Institutions of Black S&E Doctorate Recipients," NSF 08–319.

[9] Lange, S. E. 2006, "The Master's Degree: A Critical Transition in STEM Doctoral Education", Ph.D. Dissertation, University of Washington.

Syverson, P. 2003, "Data Sources", Graduate School Communicator, XXXVI, 5

b. *Identify students with unrealized potential;* recruit and support "diamonds in the rough" who can be honed for top-notch Ph.D. level work given adequate mentoring and preparation.

c. *Continually monitor student performance and remain alert to small inflections in trajectory;* do not wait for small missteps to accumulate and derail an otherwise promising student. Detect potential problems early and intervene with support quickly and often.

d. *Leverage professional networks;* connect students with the broader STEM community for mentorship and research opportunities.

e. In addition, the program includes these key elements to ensure successful student transitions:

- *Full financial support.* Rationale: Financial burden should not be an impediment to participation and satisfactory progress.
- *Joint advisory committee of both Fisk and Vanderbilt mentors.*Rationale: Track student progress and ensure student readiness for Ph.D.-level work.
- *Publication-quality Master's thesis through research in both Fisk and Vanderbilt labs.* Rationale: Develop relationships with faculty who serve as mentors, advisors and advocates. Demonstrate readiness for Ph.D.-level work through core competencies that are more predictive of success than simple numerical metrics such as GRE scores.
- *Course requirements at both Fisk and Vanderbilt.* Rationale: Demonstrating competency in core courses is essential to showing promise for Ph.D. study.

There are three main challenges to replicating the successes of the Fisk-Vanderbilt Master's-to-Ph.D. Bridge Program at other institutions, including at other major research universities:

1. *Dedicated faculty leaders at both of the bridged institutions are the single most important ingredient.* In lieu of a critical mass of URM STEM faculty who may identify with the goal increasing diversity in STEM as a core personal commitment, faculty "bridge builders" will likely need to be motivated and incentivized through institutional and external rewards (such as recognition in the tenure process and through the prestige associated with NSF CAREER awards). In truth, we expect that this will remain a fundamental challenge for replicating the program. The faculty leaders in the Fisk-Vanderbilt Bridge program view diversity in STEM as a priority for reasons that are at once strategic, moral, competitive, even patriotic—such passion and deep commitment are difficult to blueprint, export, or mass produce.
2. *The type of intensive, ongoing, one-on-one student mentoring that is so central to the Fisk-Vanderbilt Bridge model is very difficult to "scale up," depending as it does on a commitment of time and energy from faculty mentors* who already shoulder extensive demands on their time in the form of teaching, mentoring other students, managing a world-class research laboratory and team, university administrative duties, and of course a commitment to continually produce top-notch research. Fortunately, even incremental increases in the number of URM STEM Ph.D.s at one institution can represent significant gains on a national scale. For example, an institution that produces one URM Ph.D. per year in physics will produce more than five times the national average. Ph.D.s are earned one student at a time, and every single URM Ph.D. makes a difference in the national numbers.
3. *A challenge is to identify capable, promising URM students for Ph.D. study, who may come from small minority-serving institutions and/or may not have GRE scores that are competitive in comparison to the talented foreign students who apply to our programs in large numbers.* The Fisk-Vanderbilt Bridge program is built on the belief that there exists a large pool of talented URM students—who have already progressed to the baccalaureate level in STEM—with the promise and potential to continue successfully to Ph.D. level. The challenge, in other words, is to learn to recognize "unrealized potential" in a student, to recognize and nurture the human traits that make for a great scientist but that are not easily quantified—creativity, ingenuity, genius even. The Fisk-Vanderbilt Bridge program does this through an "audition" approach: By the time a student has crossed the Bridge, there is no need to guess whether the student has "what it takes" for a Ph.D. or to rely solely on "by the numbers" metrics—we know the student, have actually

watched him/her perform in the laboratory. We therefore enjoy a much richer set of data about our incoming students than is usually available in Ph.D. admissions.

Challenges to Achieving more Diversity in STEM

(additional comments and supporting material in Appendix B):

Three major challenges to achieving more diversity in science and engineering are:

1. *The very low production rate of URM STEM Ph.D.s limits the number of URM faculty in STEM available to serve as mentors and role models.* Some gains have been achieved over the past few decades in the overall number of URMs earning baccalaureate degrees in STEM disciplines, yet the number of URMs earning Ph.D.s in STEM disciplines remains very small (less than four percent of all STEM Ph.D.s awarded by American universities). Taking my own field of astronomy as an example, a recent survey of all 51 astronomy and astrophysics Ph.D.-granting programs in the U.S. counted a total of just 17 individuals who identify as URMs among the full-time faculty (2 percent of all astronomy and astrophysics faculty).[10] Consequently the number of URM faculty available to train, and to serve as role models for, the next generation of URM students in STEM remains extremely limited. An immediate five-fold increase in the production rate of URM STEM Ph.D.s over the coming decade is required if we are to achieve parity relative to the U.S. population within 30 to 35 years (see Appendix B).
2. *American citizens no longer earn the majority of STEM Ph.D.s awarded by the U.S.* Global competition in STEM has become fierce; the dominance of American students in STEM graduate programs is no longer a given. In fact, American citizens now constitute the minority (44 percent) of Ph.D. recipients from American graduate programs, across all STEM disciplines (Appendix B).
3. *The vast majority of Ph.D. programs are underutilized as training grounds for URM STEM Ph.D.s*. A disproportionate number of URM Ph.D.s in STEM disciplines are produced by a very small number of institutions—just 27 institutions produce fully one-third of all URM STEM Ph.D.s (see Appendix B). These institutions represent two very narrow segments of the higher education system in the U.S.: A few MSIs that award Ph.D.s (e.g. Howard University, University of Puerto Rico), and the very top-ranked major research universities (e.g. University of Michigan, University of California Berkeley). The overwhelming majority of Ph.D.-granting research universities (particularly second-tier research universities such as Vanderbilt) are generally underutilized as training grounds for future URM Ph.D.s in STEM.

Two noteworthy variations by STEM discipline are as follows:

1. *The small proportion of STEM Ph.D.s awarded to URMs is most acute in the physical sciences.* For example, URMs receive just two percent of all Ph.D.s awarded by American universities in physics and astronomy. Such small percentages in turn mean very small absolute numbers, making it a challenge for most URM Ph.D. students to find role models, cohort or community during their Ph.D. training. In astronomy, for example, the average Ph.D.-granting institution produces 1 URM Ph.D. every 13 years.
2. There is now emerging at the baccalaureate level a very large national pool of URM talent in the computational sciences and in several sub-disciplines of engineering. The overwhelming majority (80 percent) of these college-educated URM computer scientists and engineers exit the higher education system at the baccalaureate level. There is an opportunity to further develop this talent toward Ph.D.s through interdisciplinary programs that combine the "pure" STEM disciplines (e.g. physics, biology) with "applied" skills such as systems engineering, high-performance computing, and informatics.

Two particular challenges for a major research university such as Vanderbilt are the following:

[10] Nelson, D., & Lopez, L. 2004, "The Diversity of Tenure Track Astronomy Faculty," American Astronomical Committee on the Status of Minorities in Astronomy, Spectrum Newsletter, June 2004.

1. *The challenge of identifying the most promising STEM students for Ph.D. training.* Selecting the best students for STEM Ph.D. study is not a perfect science. Major research universities such as Vanderbilt have traditionally relied on certain quantitative and standardized metrics, such as Graduate Record Examination (GRE) scores and undergraduate grade-point average (GPA). However, many of our domestic STEM students are being out-performed on these metrics by their peers from China, India, and other nations. A straight "by the numbers" approach to Ph.D. admissions therefore results in a major underutilization of our domestic STEM talent. The challenge for a major research university such as Vanderbilt, therefore, is to maintain our high standard for excellence while identifying new ways of assessing student potential for the human traits we most value (e.g. creativity, innovativeness, entrepreneurial spirit, leadership, grit). These traits continue to distinguish American students from their peers around the world and are at the heart of our global leadership and competitiveness.
2. *The challenge of connecting the value of broadening participation to the merit basis by which STEM faculty are assessed, promoted, and rewarded.* The STEM faculty at a major research university are the engines of discovery, as well as the mentors and role models for the next generation of STEM Ph.D. students. It is imperative that STEM faculty be motivated and incentivized to lead the broadening participation charge. A particularly promising example is the NSF CAREER[11] awards. These are among the most prestigious grants that a young STEM faculty member can receive, and it requires both a cutting-edge research program and "broader impact" including broadening participation. Indeed, the NSF CAREER awards to several young faculty (including especially women and URM faculty) at Vanderbilt in the past few years have been instrumental in simultaneously launching their careers and catalyzing the successful Fisk-Vanderbilt Master's-to-Ph.D. Bridge program for broadening participation (described above).

The Federal Role in Broadening Participation in STEM

The Federal Government can play a very important role in addressing challenges and barriers to broadening participation in STEM are as follows. In particular, the government should continue to link the national interest in broadening participation in STEM to Federal R&D initiatives, particularly in the context of development and full utilization of the domestic STEM workforce. There are at least three inter-related components to this:

1. *Individual principal investigators.* Individual researchers (e.g, faculty at research universities) are the "front lines" in America's STEM competitiveness imperative. These entrepreneurial individuals can and do respond to Federal mandates in R&D funding programs. The NSF's "broader impacts" criterion, which explicitly includes broadening participation language in the evaluation of all funding proposals, is an excellent model for accomplishing this. Similarly, the NSF CAREER awards program, which recognizes and supports America's top junior STEM faculty innovators, is another excellent example by which the broadening participation goal can be linked to the national system of incentives and rewards for America's best and brightest.
2. *Research universities.* The Science and Engineering Equal Opportunities Act [SEEOA) and Executive Order 11246 remain in effect and apply to virtually all research universities.
3. *Federally funded research centers and Federal funding agencies.* Major research facilities funded and/or operated by the Federal Government or its contractors can play a critical role of leadership by example. Research centers such as the National Solar Observatory, the Department of Energy national labs, the NASA centers (e.g. Jet Propulsion Laboratory), and others, are major government R&D employers of the STEM labor force, and therefore rely critically on a healthy STEM workforce pipeline. However, with the exception of NSF facilities (NSF is explicitly mentioned in the SEEOA language), most of these Federal research centers generally do not include "broadening participation" language in their hiring or funding evaluation criteria. Extension of the NSF "broader impacts" criterion to the other Federal funding agencies (Le, DOE, NASA, NOAA, NIH, NISI) could be a powerful step forward.

[11] *http://www.nsf.gov/funding/pgm summ.jsp?pims id=503214*

We suggest three recommendations with respect to NSF specifically:

1. The NSF "broader impacts" criterion, as discussed above, used in the evaluation of all funding proposals considered by the agency has had a very positive effect in motivating individual investigators specifically, and universities more generally, to address the broadening participation imperative. The NSF CAREER awards program in particular is a promising model for linking the prestige of our best STEM university faculty to the goal of broadening participation in STEM.
2. Within NSF, some Divisions have taken the initiative to develop funding programs that specifically enable research-based collaborative partnerships between MSIs and major research universities (including NSF-funded research centers) with the goal of training URM students toward STEM Ph.D.s. Examples include the PREM [12] and PAARE [13] programs. In addition, the Innovation through Institutional Integration (a.k.a. I-cubed) program administered by the Education and Human Resources (EHR) Directorate has supports innovative programs that broaden participation in STEM and that specifically attend to "critical educational junctures" such 'as the Master's-to-Ph.D. transition.
3. *There is a need for additional "training grant" opportunities through NSF to support the basic research training of Master's and Ph.D. students.* The NSF IGERT [14] program is a very good example of a competitive and effective training grant program, with an emphasis on interdisciplinarity and on emerging new STEM sub-fields (such as the Vanderbilt-Fisk IGERT in nanoscale science and engineering). The IGERT program does not generally support graduate student training in more established areas of STEM research; there is an ongoing need for graduate students including URM Ph.D. students to receive training and development in these established fields. Examples of standing training grant programs exist at other Federal agencies, such as NIH, that could serve as templates for the development of a more general training grants program through NSF. Indeed, the model of NSF's own Research Experiences for Undergraduates (REU) program, which is a general training grants program at the baccalaureate level, could be fruitfully applied at the post-baccalaureate, Master's, and Ph.D. levels. In lieu of such training grants, Vanderbilt has so far committed $2M in institutional funds to support training of Fisk-Vanderbilt Master's-to-Ph.D. Bridge students.

Mr. Chairman, thank you again for the opportunity to testify before the Subcommittee today. I look forward to answering the Subcommittee's questions and working together to broaden participation in the STEM fields.

Appendix A: Additional Comments and Supporting Material for the Fisk-Vanderbilt Master's-to-Ph.D. Bridge Program

MSIs (including HBCUs, HSIs, and TCUs) represent large—and largely untapped—pools of URM talent in STEM. For example, the top 15 producers of African American physics baccalaureates in the U.S. are all HBCUs, and just 20 HBCUs were responsible for producing fully 55 percent of all African American physics baccalaureates in the U.S. between 1998 and 2007.[15] In comparison to majority institutions, which in 2006 produced on average 9,0 URM bachelor's degrees per institution per year in physics, computer science, and engineering, MSIs produced on average 36.1 URM degrees per institution per year in these disciplines (data from NSF WebCASPAR). Moreover, these institutions are successful at placing students in Ph.D. programs. For example, among the U.S. baccalaureate-origin institutions of African American STEM Ph.D. recipients for the years 1997–2006, the top 8, and 20 of the top 50, were HBCUs.[16]

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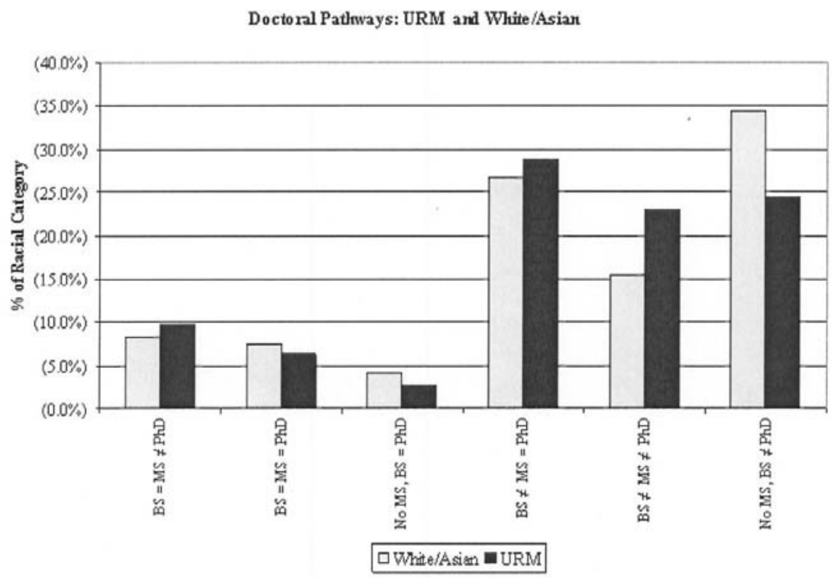
[12] The PREM (Partnerships for Research and Education in Materials] program is administered by the NSF Division of Materials Research (DMR) in the Math and Physical Sciences (MPS) Directorate.

[13] The PAARE (Partnerships for Astronomy and Astrophysics Research and Education) program is administered by the NSF Division of Astronomical Sciences (AST) in the Math and Physical Sciences (MPS) Directorate.

[14] Integrated Graduate Education and Research Traineeships (IGERT) is an NSF-wide program.

[15] AIP Statistical Research Center, Enrollment and Degrees Survey.

[16] Burrelli, J., & Rapoport, A. 2008, "Role of HBCUs as Baccalaureate-Origin Institutions of Black S&E Doctorate Recipients," NSF 08–319.



The graph shows comparisons between URMs and White/Asian students, based on differen permutations of the educational pathway to the PhD. An equal sign indicates degrees earned from the same institution. The fourth and sixth comparisons from the left show the "traditional" paths to the PhD, in which the student earns the bachelors degree from institution A, and either receives both the masters degree and the PhD from institution B or else forgoes the masters degree entirely. The fifth comparison from the left shows the case for earning the bachelors degree at institution A, a "terminal" masters degree at institution B, and PhD from institution C. URMs are much more likely to take this latter path than non-URMs. Adapted from Lange (2006), based on analysis of 80,739 PhDs earned in STEM fields, 1998 to 2002.

The number of MSIs with research-active faculty, and that offer advanced STEM degrees, has undergone dramatic growth. The growth of MSI Master's degree programs in particular is striking. For example, between 1987 and 2006, the number of MSIs offering Master's degrees in the physical sciences or engineering increased by 79 percent, and the number of URMs earning Master's degrees from these institutions increased correspondingly by 533 percent (from 119 URM degrees in 1987 to 753 in 2006; data from NSF WebCASPAR). Consequently, as shown in the chart below, URMs who earn Ph.D.s in STEM fields are about 50 percent more likely than their non-URM counterparts to have earned a "terminal" master's degree (i.e. not a master's degree earned as part of a Ph.D. program) before eventually transitioning to a Ph.D. program.[17] Thus the Master's degree is a critical, and previously poorly understood, stepping stone for many URMs in STEM. Moreover, the transition from the Master's to the Ph.D. is therefore a critical educational juncture at which students without suitable mentoring and guidance may be lost from the STEM Ph.D. pipeline.

Fisk-Vanderbilt Master's-to-Ph.D. Bridge Program Facts & Figures

- In 2006, U.S. institutions awarded to Black U.S. citizens 12 Ph.D.s in physics (out of 637 U.S. citizen Ph.D.s; 1.9%) [data from NSF]. The average per Ph.D.-granting institution in the U.S. is 1 minority Ph.D. in biology, physics, materials science, and astronomy every two, five, nine, and 13 years, respectively.
- The *Fisk-Vanderbilt Bridge program* is on track to award *ten times* the U.S. institutional average number of minority Ph.D. recipients in astronomy, *nine*

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[17] Lange, S. E. 2006, "The Master's Degree: A Critical Transition in STEM Doctoral Education", Ph.D. Dissertation, University of Washington.
Syverson, P. 2003, "Data Sources", Graduate School Communicator, XXXVI, 5

times the average in materials science, *five times* the average in physics, and two times the average in biology (the biology track was newly added in 2007). Our most recent incoming cohort alone includes more minority students in astronomy than the current annual production of minority Ph.D. astronomers for the entire U.S.

- Our *Bridge* students have been awarded the nation's top graduate fellowships from NSF (GRF and IGERT) and NASA (see Table 1 below).
- Extramural grants received to support the *Bridge* program—support for graduate students, faculty, and related undergraduate research—now exceed $25.1M (see Table 2 below).
- Vanderbilt and Fisk now provide significant institutional support in the form of tuition waivers, RA stipends, and administrative support (see Table 2 below).

Table 1.—Fisk-Vanderbilt Master's-to-Ph.D. Bridge Program Students to Date

Student	Ethnicity/ Gender*	Admit Year	Undergraduate Institution	Discipline	Current Institution/ Status
S. Babaloloa	A/M	2004	University of Ilorin, Nigeria	Materials	UA Huntsville (faculty)
T. LeBlanc	H/M	2004	UMET, Puerto Rico	Astronomy	Vanderbilt (NASA Fellow)
J. Harrison	A/M	2004	Chicago State Univ.	Materials	Case Western (IGERT fellow)
H. Jackson	A/F	2004	Fisk University	Physics	Wright State (USAF Co-op)
J. Rigueur	A/M	2004	Fisk University	Physics	Vanderbilt (IGERT fellow)
V. Alexander	A/M	2005	Florida A&M Univ.	Physics	Dropped out, status unknown
J. Bodnarik	W/F	2005	USAF Academy	Astronomy	Vanderbilt (NASA Co-op)
M. Harrison	A/F	2005	Xavier University	Materials	Vanderbilt (IGERT fellow)
J. Isler	A/F	2005	Norfolk State Univ.	Astronomy	Yale (NSF graduate fellow)
E. Jackson	A/M	2005	Norfolk State Univ.	Materials	Vanderbilt (IGERT fellow)
J. Jones	A/F	2005	Grambling State U.	Materials	Vanderbilt (IGERT fellow)
T. Van	H/M	2005	UMET, Puerto Rico	Biology	Vanderbilt
L. Zambrano	H/F	2005	UMET, Puerto Rico	Astronomy	Dropped out (now at UTB)
D. Foster	A/M	2006	UMBC	Astronomy	Vanderbilt
A. Ruffin	A/F	2006	Tennessee State U.	Physics	Oak Ridge National Lab
D. Campbell	A/M	2006	Rhodes College	Physics	Vanderbilt

Table 1.—Fisk-Vanderbilt Master's-to-Ph.D. Bridge Program Students to Date—Continued

Student	Ethnicity/ Gender *	Admit Year	Undergraduate Institution	Discipline	Current Institution/ Status
R. Santos	H/M	2006	UMET, Puerto Rico	Physics	Dropped out, status unknown
E. Walker	A/F	2006	Alabama A&M U.	Materials	Vanderbilt (IGERT fellow)
J. Cooper	A/F	2007	Rust College	Biology	U Chicago
D. Gunther	W/F	2007	Austin Peay State	Materials	Vanderbilt
L. Palladino	W/F	2007	Hofstra U.	Astronomy	Vanderbilt
C. Mack	A/M	2007	UNC Chapel Hill	Astronomy	Vanderbilt
A. Parker	A/M	2007	Austin Peay State	Materials	Vanderbilt
E. Morgan	A/F	2007	Tennessee State U.	Astronomy	Vanderbilt
F. Bastien	A/F	2008	U. Maryland	Astronomy	Vanderbilt
L. Jean	H/F	2008	U. New Hampshire	Biology	Vanderbilt
M. Richardson	A/M	2008	Fisk University	Astronomy	Vanderbilt
S. Haynes	A/F	2007	Tennessee State U.	Astronomy	Fisk (MS expected 2010)
F. Colazo	H/M	2008	Fisk University	Astronomy	Fisk (MS expected 2010)
B. Kamai	N/F	2008	U. Hawaii	Astronomy	Fisk (MS expected 2010)
J. Harris	A/F	2008	Grambling State U.	Astronomy	Fisk (MS expected 2010)
S. Lawrence	A/F	2008	Clark U.	Biology	Fisk (MS expected 2010)
S. Satchell	A/F	2008	Saint Paul's U.	Biology	Fisk (MS expected 2010)
B. Cogswell	A/F	2009	Florida State U.	Physics	Fisk (MS expected 2011)
M. Williams	A/M	2009	Morehouse Univ.	Astronomy	Fisk (MS expected 2011)

* Ethnicity/Gender: H=Hispanic, A=African American, N=Native Hawaiian, W=White, F=Female, M=Male.

Table 2.—Funding Received to Date Supporting Bridge Students and Faculty

Agency	Program	Years	Lead Faculty (PI in boldface)	Amount
NSF	CAREER	2004–09	**K. Stassun (Vanderbilt)**	$1M
NASA	MUCERPI	2004–07	**A. Burger (Fisk),** K. Stassun (Vanderbilt), E. Collins (Fisk), D. Ernst (Vanderbilt), S. Morgan (Fisk)	$800K

Table 2.—Funding Received to Date Supporting Bridge Students and Faculty—Continued

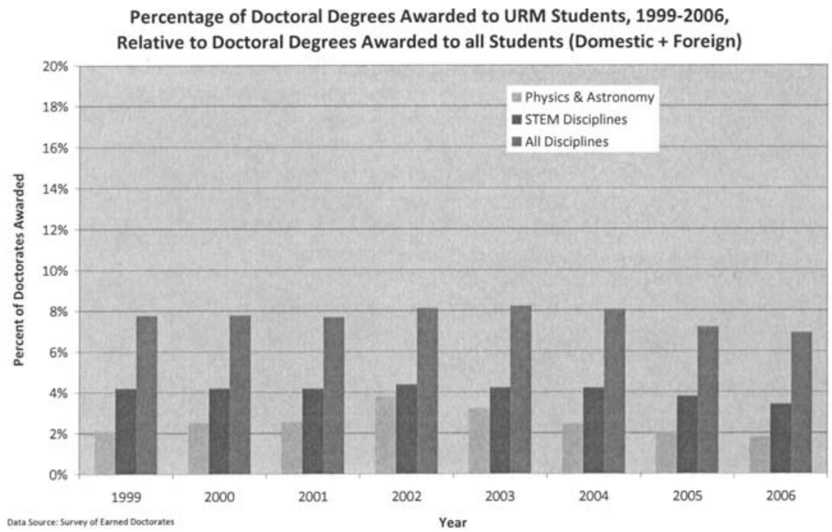
Agency	Program	Years	Lead Faculty (PI in boldface)	Amount
NSF	CREST/ Materials Sci.	2004–14	**E. Collins (Fisk),** A. Burger (Fisk), W. Lu (Fisk), S. Morgan (Fisk), R. Mu (Fisk)	$9.4M
DOE, DHS, DOD, NASA	Materials Science	2004–09	**A. Burger (Fisk)**	$3.5M
NSF	REU	2004–10	**E. Collins (Fisk),** A. Burger (Fisk), S. Morgan (Fisk)	$600K
NSF	REU	2007–10	**D. Ernst (Vanderbilt),** K. Stassun (Vanderbilt)	$300K
NSF	PAARE (AST)	2008–13	**K. Stassun (Vanderbilt),** A. Burger (Fisk), K. Holley Bockelmann (Vanderbilt), M. Watson (Fisk)	$2.2M
NSF	CAREER	2009–14	**K. Holley-Bockelznann (Vanderbilt)**	$1.1M
NSF	I–Cubed	2009–14	**K. Stassun & R. McCarty (Vanderbilt),** S. Rosenthal (Vanderbilt), E. Collins (Fisk)	$1.25M
DOEd	GAANN	2009–12	**K. Stassun,** D. Ernst (Vanderbilt), E. Collins (Fisk)	$900K
Vanderbilt Provost	VIDA [18]	2007–12	**K. Stassun (Vanderbilt)**	$2M
Vanderbilt A&S Dean	Biological Sciences [19]	2008–11	**D. Webb (Vanderbilt),** J. Ike (Fisk), K. Stassun (Vanderbilt)	$150K
Fisk Provost	Physics/ Biology [20]	2004–14	**E. Collins (Fisk),** S. Morgan (Fisk), J. Ike (Fisk)	$937K

[18] Vanderbilt Office of the Provost provides support for stipend/tuition for 4 Bridge students per year and a full-time program coordinator.
[19] The Dean of Vanderbilt Arts & Science provides seed support for 1 Bridge student per year in Biological Sciences (stipends + tuition).
[20] Fisk provides full tuition waivers for approximately 6 Bridge students per year in these Master's degree programs.

Appendix B: Additional comments and supporting material for Challenges to Broadening Participation in STEM

The very low number of underrepresented minorities (URMs) earning doctoral degrees in STEM disciplines is a problem in need of focused attention and rapid improvement. Individuals who exit the higher education STEM pipeline with baccalaureate degrees are in an excellent position to join the national STEM workforce with fulfilling and gainful employment. However, it remains a critical national interest to sustain a vital pipeline of individuals earning doctoral degrees in STEM. These are the best and brightest of our national brain trust: the future leaders of our world-class laboratories, the future principal investigators of federally funded R&D initiatives, the future teachers, mentors, and role models for subsequent generations of America's explorers. It matters, therefore, that these future STEM leaders reflect the "face of America."

Graduate STEM programs in the U.S. have become increasingly effective in the training of STEM leaders for the rest of the world. Indeed, in many STEM disciplines, the proportion of all Ph.D.s awarded to non-US citizens or permanent residents now exceeds 50 percent. As one example relevant to one Federal agency (NASA), in 2008 there were 265 Ph.D.s awarded by U.S. institutions in aerospace, aeronautic, and astronautical engineering, of which 121 were awarded to U.S. citizens and permanent residents; that is, less than half of all Ph.D.s awarded in these NASA-related disciplines are now being awarded within the domestic U.S. STEM workforce. More generally, 44 percent of all STEM Ph.D.s are awarded by U.S. institutions to U.S. citizens and permanent residents[21].



To be sure, graduate students from other countries contribute greatly to the intellectual community at an institution like Vanderbilt, and bring much to the institution in terms of diversity. At the same time, however, large segments of the U.S. population remain grossly underutilized. Over the period 1999–2006, U.S. citizen URMs represented on average just four percent of all STEM Ph.D.s awarded by U.S. institutions (see chart above), whereas these groups comprise more than 30 percent of the Ph.D.-age population of the U.S. Foreign students earned almost five times as many Ph.D.s in 2006 than did URM citizens of the U.S. As noted by the Woodrow Wilson Foundation report, *Diversity and the Ph.D.*: "educating the world's students while neglecting significant groups of the national population is a vast inequality at the highest academic level".

Low as is the overall representation of URMs in STEM fields, some disciplines prove particularly challenged. In general the physical sciences show the most severe underrepresentation of URMs. For example, in physics and astronomy the proportion of Ph.D.s awarded to URMs in 1999–2006 averaged just barely over two percent, again compared to the more than 30 percent that URMs represent in the Ph.D.-age population of the U.S. In 2008, U.S. institutions awarded to Black U.S. citizens just 15 Ph.D.s in physics (out of 905 U.S. citizen Ph.D.s; 1.7%) [NSF WebCASPAR]. Of course, Ph.D.s are earned one individual at a time, each within a department at one institution. It is at this level of granularity that the challenge of broadening participation must be met. For example, in physics the statistics translate into an average of 1 URM Ph.D. per Ph.D.-granting institution every five years. In materials science, it is 1 URM Ph.D. per institution on average every nine years. In astronomy, it is 1 URM Ph.D. per institution on average every 13 years.

One consequence of this very low URM Ph.D. production rate is that there continues to be a very small number of URM STEM faculty at major research universities to serve as mentors and role models for the next generation of URM STEM Ph.D.s. Taking astronomy as an example, a recent survey of all 51 astronomy and astrophysics Ph.D.-granting programs in the U.S. counted a total of just 17 individuals who identify as URMs among the full-time faculty (2 percent of all astronomy and astrophysics faculty)[22]. These Ph.D.-granting programs today collectively award approximately 4±1 URM Ph.D.s per year (data from American Institute of Physics),

[21] Data source: Survey of Earned Doctorates (NSF/NIH/USED/NEH/USDA/NASA).

[22] Nelson, D., & Lopez, L. 2004, "The Diversity of Tenure Track Astronomy Faculty," American Astronomical Committee on the Status of Minorities in Astronomy, Spectrum Newsletter, June 2004.

an average per Ph.D.-granting institution of 1 URM Ph.D. every 13 years[23]. Over the past 20 years this represents a slight increase in absolute number from 3±1 URM Ph.D.s in 1988. The corresponding fraction of URM Ph.D.s has been roughly flat at 2–4 percent of the total[24], while the proportion of URMs in the U.S. population grew by 33 percent during this same time period (from 20.9 percent in 1988 to 27.0 percent in 2008; data from U.S. Census). Over the past decade, the proportion of URM Ph.D.s in physics and astronomy has been a factor of 2 smaller than in all other science and engineering (STEM) fields, and a factor of 4 smaller than in all fields. On average about three percent of the STEM workforce turns over each year. To achieve parity in the number of URMs entering the stream of permanent astronomy and astrophysics positions, and assuming similar attrition rates among URM Ph.D.s as for astronomy and astrophysics Ph.D.s as a whole, the number of URM Ph.D.s would need to increase from 5 per year to approximately 40 per year, an eight-fold increase. At this pace, the field overall could achieve parity in 30 to 35 years.

Inside Higher Ed (3/11/2010, Jaschik)[25] reports that a study from Cornell University's Higher Education Research Institute "finds a statistically significant relationship between [URM] students who plan to be a science major having at least one [URM] science instructor as freshmen and then sticking to their plans. The finding could be significant because many students (in particular members of URM groups) who start off as science majors fail to continue on that path—so a change in retention of science majors could have a major impact." Joshua Price, who authored the report on the study, said, "These results suggest that policies to increase the [URM] representation among faculty members might be an effective means of increasing the representation of [URMs] who persist and ultimately graduate in STEM fields."

The mentoring and training of URM STEM Ph.D.s is not shared equally among Ph.D.-granting institutions. Indeed, fully one-third of all URM STEM Ph.D.s in the U.S. are produced by just 27 institutions. As shown in the table below, these 27 institutions represent two distinct groups of institutions: (1) The few MSIs that award Ph.D.s (such as Howard University, University of Puerto Rico, Carlos Albizu University), and (2) the very top-ranked Ph.D.-granting institutions (such as University of Michigan, University of California Berkeley, Harvard University). In comparison, the overwhelming majority of Ph.D.-granting programs in the U.S. on average produce single-digit numbers of URM STEM Ph.D.s, or none at all. These Ph.D.-granting programs, representing broadly the second-tier of research universities, are currently underutilized for broadening participation of URMs in attaining STEM Ph.D.s.

Engaging URM individuals from a broader base of "applied" STEM backgrounds could substantially, and quickly, expand the pool of qualified individuals in areas of the "pure" disciplines that are likely to experience growth in the coming decade. For example, the development of new instruments for high-energy physics experiments, for space-based astrophysics missions, for climate-change research, etc., will require technical expertise from a variety of engineering disciplines, including systems engineering and design, and innovations in detector technologies stemming from materials science. Similarly, the increasing importance of high-performance computing and informatics-based approaches—for large scale simulations, for data-intensive surveys, for data-mining infrastructures across all STEM disciplines—will require expertise that may be tapped from the ranks of computer science graduates.

[23] Stassun, K.G. 2005, "Building Bridges to Diversity", Mercury, 34 (3), 20

[24] These fractions are relative to U.S. citizen and permanent resident Ph.D.s only. Since foreign students account for approximately 50% of all physics and astronomy Ph.D.s awarded in the U.S. (Ref: Survey of Earned Doctorates), the true fraction of Ph.D.s earned by URMs is a factor of 2 smaller.

[25] *http://www.insidehighered.com/news/2010/03/11/race*

STEM Doctoral Degrees Awarded to Underrepresented Minorities (American Indian, Black, Hispanic)

	Institution	2003-2007
	All institutions	9,677
1	Carlos Albizu University	323
2	Howard University	219
3	University of Michigan-Ann Arbor	201
4	Nova Southeastern University	199
5	University of Puerto Rico-Rio Piedras Campus	192
6	University of Florida	162
7	University of California-Berkeley	143
8	Stanford University	123
9	University of California-Los Angeles	114
10	CUNY Graduate School and University Center	108
11	Carlos Albizu University-Miami Campus	103
12	Ponce School of Medicine	103
13	Purdue University-Main Campus	98
14	The University of Texas at Austin	97
15	University of Maryland-College Park	96
16	Alliant International University	90
17	Harvard University	90
18	Texas A & M University	89
19	University of California-San Diego	86
20	University of North Carolina at Chapel Hill	86
21	Michigan State University	85
22	George Mason University	82
23	Pennsylvania State University-Main Campus	81
24	Georgia Institute of Technology-Main Campus	81
25	University of Arizona	80
26	California School of Psychology, Los Angeles	78
27	University of Illinois at Urbana-Champaign	77

STEM doctoral degrees awarded by leading institutions, by race/ethnicity of U.S.-citizen and permanent-resident underrepresented minority graduates: 2003–07. SOURCE: National Science Foundation, Division of Science Resources Statistics, special tabulations of U.S. Department of Education, National Center for Education Statistics, Integrated Postsecondary Education Data System, Completions Survey, 2003–07.

In 2006, for example, URMs earned a total of 17,813 baccalaureate degrees in physics, computer science, and engineering [data from NSF WebCASPAR]. In comparison, 3,598 (20.2 percent) of these earned a master's degree, and 292 (1.6 percent) went on to earn a Ph.D. Thus the pool of URMs with relevant STEM training is substantial, but an overwhelming majority of these individuals currently exit the higher education pipeline with a bachelor's degree. The opportunity to pipeline URM STEM baccalaureates into advanced degrees in STEM disciplines is large.

Biography for Keivan G. Stassun

After earning B.A. degrees in physics and in astronomy from the University of California at Berkeley in 1994, Stassun earned the Ph.D. in astronomy from the University of Wisconsin–Madison in 2000. Stassun then served as assistant director of the NSF-funded GK–12 program at UW–Madison, connecting STEM graduate students with public K–12 schools both to enhance K–12 science teaching and to provide leadership development for STEM graduate students. He then served for two years as a NASA Hubble Space Telescope postdoctoral research fellow before joining the Vanderbilt faculty in 2003.

A recipient of a CAREER award from NSF and a Cottrell Scholar Award from the Research Corporation, Stassun's research on the birth of stars and planetary systems has appeared in the prestigious research journal *Nature,* has been featured on NPR's *Earth & Sky,* and has been published in more than 40 peer-reviewed scholarly journal articles. In 2006, the *Vanderbilt Initiative in Data-intensive Astrophysics (VIDA)* was launched as a $2M pilot program in astro-informatics, with Stassun as its first director.

The Stassun research group includes four postdoctoral associates, seven doctoral students, seven master's students, and numerous undergraduate interns. Now an associate professor of astronomy at Vanderbilt, Stassun is also adjunct professor of physics at Fisk University, and serves as co-director of the *Fisk-Vanderbilt Masters-to-Ph.D. Bridge Program.*

Since 2004, the Fisk-Vanderbilt Bridge Program has attracted 34 students, 31 of them underrepresented minorities (60% female), with a retention rate of 92%. The first Ph.D. to a Fisk-Vanderbilt Bridge student was awarded in 2009, just five years after the program's inception. In 2011, Vanderbilt will achieve the distinction of becoming the top research university to award the Ph.D. to underrepresented minorities in physics, astronomy, and materials science. Already, Fisk has become the top producer of Black U.S. recipients of the master's degree in physics, and one of the top ten producers of physics M.A. degrees overall. The Fisk-Vanderbilt Bridge Program is supported by institutional funds from Vanderbilt and Fisk as well as extramural grants from NSF and NASA.

From 2003 to 2008, Stassun served as chair of the American Astronomical Society's Committee on the Status of Minorities, as a member of the Congressional FACA Astronomy & Astrophysics Advisory Committee, and presently serves on the advisory board for the NSF-funded Institute for Broadening Participation and on the Workforce and Diversity Committee of the Associated Universities for Research in Astronomy.

Chairman LIPINSKI. Thank you, Dr. Stassun.

The Chair will now recognize Dr. Yarlott.

STATEMENT OF DR. DAVID YARLOTT, PRESIDENT OF LITTLE BIG HORN COLLEGE, AND CHAIR OF THE BOARD OF DIRECTORS FOR THE AMERICAN INDIAN HIGHER EDUCATION CONSORTIUM

Dr. YARLOTT. Mr. Chairman, distinguished members of the Committee, my name is Baluxx Xiassash—Outstanding Singer. I am a member of the Uuwuutasshe Clan and also a child of the Uuwuutasshe Clan of the Apsáalooke, or Crow, Indians. The Crow Reservation is located in south central Montana and contains about 3,000 square miles, a territory larger than the State of Rhode Island.

In the early 1980s, my tribe established Little Big Horn College with the goal of creating a lasting tradition of higher education for a good path into the future for the Crow people. I am proud to say that I am a product of my tribe's commitment to higher education. As a student, I graduated from Little Big Horn College. As a faculty member, I taught at the college. Later after earning advanced degrees, I became an administrator, and now, as President of Little Big Horn College, it is my responsibility to keep building the path into the future for my people, a path that includes new technologies needed for environmental science and partnerships in emerging STEM fields.

On behalf of Little Big Horn College and the 35 other tribal colleges and universities that comprise the American Indian Higher Education Consortium, thank you for inviting me here to testify on cultural and institutional barriers to broadening student participation in STEM programs. I am pleased to comment on efforts to overcome these barriers at tribal colleges and provide a few recommendations on strategies for improving Federal agency support to ensure that all Americans, including the first Americans, can succeed in high-quality STEM education programs and successfully enter a national STEM workforce.

This morning I will speak briefly on three topics: the tribal college movement, the role of tribal colleges in the NSF's TCU [Tribal Colleges and Universities] program and broadening participation of American Indian students in STEM fields and the challenges and barriers we face, and possible strategies for improving STEM broadening participation programs.

Mr. Chairman, because I do not know how well acquainted you or the members of the Committee are with tribal colleges, I will try to give you a brief sketch of our institution. Simply put, American Indian tribal colleges and universities are young, geographically isolated, poor, and almost unknown to mainstream America. Our institutions are also extraordinarily effective catalysts for revitalization and change, so much so that we have been called "higher education's best-kept secret". Tribal colleges are planting seeds of hope for the future, sustaining native languages, cultures and traditions and helping to build stronger tribal economies and governments. Yet the oldest tribal college is actually quite young. My institution, Little Big Horn College, celebrated its 30th anniversary this year. Our oldest institution, Diné College, turned 40 last year.

The tribal college philosophy is simple: to succeed, American Indian higher education must be locally and culturally based, holistic and supportive. That education system must address the whole person: mind, body, sprit and family. In only a few short decades, tribal colleges have grown from very humble beginnings to thriving academic centers. Little Big Horn College began in the early 1980s in two trailers and a garage that was serving as a barn. In the early years, our college had about 30 students. Today, the college averages more than 400 students each semester.

Although tribal colleges and universities have made unprecedented strides in addressing the higher education needs of American Indians, much work and many challenges remain. Of all groups in the United States, American Indian students have the highest school dropout rates in the country. Less than half of all American Indian high school students actually graduate. If these students eventually do pursue higher education, it is most often through tribal colleges, which like other community colleges are open-admission institutions.

In addition to offering daily preparation and testing, tribal colleges face challenges with remediation developmental education. On average, more than 75 percent of all TCU students must take at least one developmental course, most often pre-college mathematics. It goes without saying that a tremendous amount of TCU resources are spent addressing the failings of the K–12 education system. For this reason, TCUs have developed strong partnerships with their K–12 feeder schools. We are working often through our NSF–TCU [Tribal Colleges and Universities Program] programs to engage young students early on and consistently in community and culturally relevant science and math programs. However, most of our STEM programs operate on soft competitive funding, and prior to NSF–TCUP, most tribal colleges were unable to secure the resources needed to build high-quality STEM programs. We simply were not able to compete successfully in STEM programs sponsored by NSF and other Federal agencies.

Beginning in fiscal year 2001, NSF–TCUP changed this by making available a central capacity building assistance and resource to tribal colleges. In less than ten years, NSF–TCUP has become the primary Federal program for building STEM capacity at tribal colleges. The program can be credited with many success stories.

More American Indians are entering STEM education and STEM professions. Little Big Horn College went from three to four science students in the late 1990s to more than 50 science majors today. STEM faculty are becoming more effective and engaged. At my college, we have gone from a STEM faculty that was completely non-Native to seven Crow STEM faculty, five of whom are alumni of the college. Students are becoming involved in cutting-edge and community-relevant research in significantly greater numbers. For the past few years, we have had an exciting summer robotics program at Little Big Horn College.

Partnerships between TCUs and major research institutions are emerging as our capacity grows in the areas of research and education, including pre-engineering. We believe that NSF–TCUP could serve as a model for our Federal agencies working with our institutions to overcome barriers to broadening participation.

However, outside of the TCU program, NSF is broadening participation effort has not been entirely successful. Throughout our history, states and mainstream institutions have taken advantage of tribal colleges and their students, adding us to their grant proposals and including our students in their statistical reports without ever speaking to us or even notifying us that we are being used to help them secure funding. As NSF's broadening participation requirement has grown in importance, the number of proposals from mainstream institutions seeking to include tribal colleges has increased dramatically. TCU faculty simply are not competitive in NSF-sponsored grant competitions because our institutions lack the funding needed to hire experienced researchers and adequate support staff including grant writers and assessment professionals.

Another problem facing TCUs is the size and remoteness of our rural institutions. 'How many students are we going to be able to impact' is a common question for our small institutions. How many Native students are in mainstream university science programs? The answer is typically one to three students based on self-reporting.

My testimony includes several recommendations, but this morning I will only mention a few. First, we urge you to sustain the NSF TCU program as a separate program designed to meet the unique needs of our students. Given the limited pool of TCU applicants, 33 accredited TCUs, and the need to build STEM programs from the ground up, awards made under NSF–TCUP must be for a period of ten years, or alternatively, five years with ongoing support for an additional five years, provided the programs meet appropriate NSF criteria for satisfactory progress. This is consistent with other successful NSF capacity-building programs. NSF program staff should not cut the pie into even smaller and smaller pieces by prioritizing purpose within NSF–TCU program new areas. TCUs should be allowed to design projects that meet our community's needs as long as they are consistent with the overall goals of the NSF program. We request assistance in enforcing and measuring compliance with a requirement that any collaborative proposal involving TCUs must include letters of support and commitment from the TCUs or AIHEC. This will stop ongoing abuses by mainstream institutions to game the broadening participation requirement. In the 1990s, through NSF's Tribal College Rural

Systemic Initiatives, 20 TCUs partnered with the local school districts to lead whole system change involving parents, tribal governments, schools and private sector. We urge you to look into the outcomes of the program and consider reestablishing it.

Over the past few years and as a result of changing law and policy, EPSCoR programs are finally beginning to include TCUs and state-based programs. While we would offer a specific TCU EPSCoR, if that is not possible, we ask that all EPSCoR programs at TCU states clearly articulate, with funding commitments, their outreach to TCUs. EPSCoR programs should be held accountable to work with tribal colleges as they work with state-supported public institutions.

My written testimony includes several other recommendations which we will be pleased to discuss with you at your convenience. I will conclude this morning by saying that we are grateful, Mr. Chairman, for this opportunity to share our story, our successes and our needs with you today. We look forward to working with you to achieve broader participation in STEM degree programs to achieve our Nation's post-secondary education and STEM workforce goals. Thank you.

[The prepared statement of Dr. Yarlott follows:]

PREPARED STATEMENT OF DAVID YARLOTT

Mr. Chairman and distinguished members of the Committee, on behalf of my institution, Little Big Horn College in Crow Agency, Montana and the 35 other tribally-chartered colleges and universities that collectively are the American Indian Higher Education Consortium, thank you for inviting me to testify on the institutional and cultural barriers to broadening student participation in science, technology, engineering, and mathematic degree programs. I am pleased to comment on efforts to overcome these barriers at Tribal Colleges and Universities and to provide a few recommendations on strategies for increasing and improving Federal agency support for efforts to ensure that all Americans, including the First Americans, can succeed in high quality STEM education programs and successfully enter the national STEM workforce.

My name is *Baluxx Xiassash*—Outstanding Singer. I am a member of the *Uuwuutasshe* Clan and also a child of the *Uuwuutasshe* Clan of the Apsáalooke or Crow Indians. The Crow reservation is located in what is now south-central Montana and contains about 3000 square miles—a territory larger than the state of Rhode Island—of rolling hills, high plains, grasslands, badlands water and wetlands. In the early 1980s, my tribe established Little Big Horn College, forging a new tradition in education to nurture Crow Indian professionals whose life work would build the Crow community. The goal was to establish a lasting tradition of advanced training and higher education, for a good path into the future for the Crow People. I am proud to say that I truly am a product of my tribe's commitment to higher education: as a student, I graduated from Little Big Horn College; as a faculty member, I taught at the college. Later, after earning advanced degrees, I became an administrator, and now, as president of Little Big Horn College, it is my responsibility to keep building the path into the future for my people, a path that includes new technologies, Native and environmental science, and partnerships in emerging STEM fields.

This morning, I will speak briefly on three topics: The Tribal College Movement in general; the role of Tribal Colleges in broadening participation of American Indian students in STEM fields and the challenges and barriers facing our institutions as we carry out this work; and finally, the role of the National Science Foundation's TCU program in helping our institutions to develop STEM degree programs and possible strategies for improving the program. I ask that my written statement, along with attachments, be included in the Hearing Record.

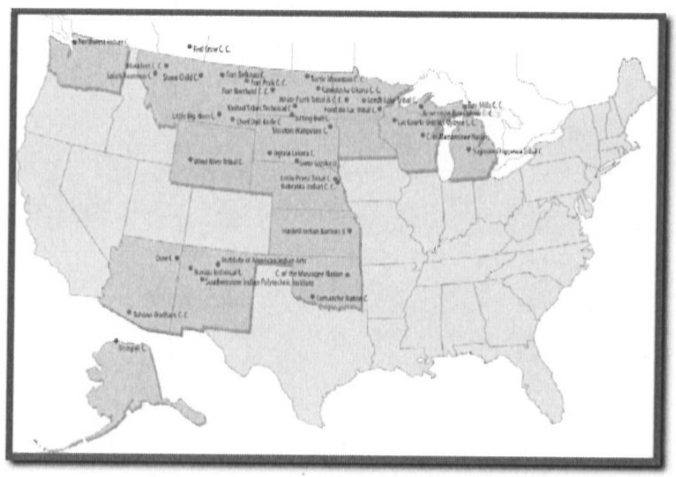
BACKGROUND: THE TRIBAL COLLEGE MOVEMENT

Mr. Chairman, I do not know how well acquainted you or the members of this Committee are with Tribal Colleges and Universities, as I do not believe we have ever testified before you, or interacted with you or your staff prior to last month. Perhaps you do not know of our near daily struggles to survive as the most poorly funded institutions of higher education in the country, or of our tremendous successes, from our work to build self esteem and change the life and future of a student through a nurturing educational environment that is culturally-based and relevant to that student, to our efforts to build stronger and more prosperous Tribal nations through the restoration of our languages, applied research on issues relevant to our land and our people, workforce training in fields critical to our reservation communities, and community-centered economic development and entrepreneurial programs.

American Indian tribally chartered colleges and universities are young, geographically isolated, poor, and almost unknown to mainstream America. Our institutions are also extraordinarily effective catalysts for revitalization and change—so much so that we have been called "higher education's best kept secret."

Located in some of the most rural and impoverished regions of this country, Tribal Colleges are planting resilient seeds of hope for the future; nurturing and sustaining languages, cultures, and traditions; and helping to build stronger tribal economies and governments. Yet, the oldest Tribal College is younger than many of the people in this room. My institution, Little Big Horn College, celebrated its 30th anniversary this year. Our oldest institution, Diné College on the Navajo Nation, turned 40 last year.

The Tribal College philosophy is simple: to succeed, American Indian higher education must be locally and culturally based, holistic, and supportive. The education system must address the whole person: mind, body, spirit, and family. Today, the nation's 36 tribal colleges are located throughout Indian Country: all seven tribes in Montana and all five in North Dakota have colleges. Tribal Colleges are also located in the Southwest, the Great Lakes, and the upper Northwest. We are expanding in all regions, including Alaska and Oklahoma, and through distance education programs, our colleges are reaching all of Indian Country.



In only a few short decades, Tribal Colleges have grown from very humble beginnings to thriving academic centers. Little Big Horn College, for example, began in the early 1980s in two trailers and a garage that was serving as a barn. In the early years, the college had about 30 students. Today, the college averages more than 400 students each semester and focuses on 10 degree programs in areas critical to our tribe's economic and community development.

Little Big Horn College, like all Tribal Colleges, is first and foremost an academic institution, but because of the number of challenges facing Indian Country—high unemployment, poorly developed economies, significant health issues, and lack of stable community infrastructures—Tribal Colleges are called upon to do much more than provide higher education services. Tribal Colleges, such as Little Big Horn College, often run entrepreneurial and business development centers. Many TCUs are the primary GED and Adult Basic Education provider on their reservations, and all TCUs provide a variety of evening, weekend training and para-professional programs for tribal employees, BIA and IHS staff; K–12 schools, tribal courts and justice system staff, and many others. TCUs operate day care centers, health promotion and nutrition programs, community gardens, and often, the community library and tribal museum or archives. Tribal Colleges have strong partnerships and linkages with the local K–12 education system, offering Saturday and summer "bridge" programs for high school students, running summer camps for youth, and providing after-hours gymnasiums and computer labs for young people.

In terms of agriculture and land-based programs, Tribal Colleges are working diligently to sustain our lands and waters. With 75 percent or more of all tribal land being forested or agriculture based, sustaining our environment is of critical importance to our people. Several TCUs are involved in climate change research and education projects, funded by NSF and the National Aeronautics and Space Administration. This semester, 15 TCUs launched a distributed, online Introduction to Climate Change course, developed collaboratively from a Native perspective through funding awarded to AIHEC by NSF.

Perhaps most important, Tribal Colleges are actively and aggressively working to preserve and sustain their own tribal languages and cultures. All TCUs offer Native language courses, and in fact, passing a language course is a condition of graduation from a TCU. In some cases, the tribal language would have been completely lost if not for the Tribal College. Turtle Mountain Community College in Belcourt, North Dakota, was established primarily for this purpose, and over the years, its success in preserving and revitalizing the Turtle

Mountain Chippewa language has been unparalleled. Fort Belknap College in Montana runs a K–6 language immersion school, right on campus. At the White Clay Immersion School, children learn the White Clay language and culture in addition to subjects they would normally study at any other school.

Many TCUs offer unique associate and bachelor degree programs, as well as in-service training, in elementary education. At the TCUs, teacher education programs follow cultural protocols and stress the use of Native language in everyday instruction. Well over 90 percent of teachers who graduate from a TCU teacher education program begin teaching on the reservation shortly after graduation, providing positive role models to Indian children.

Finally, Tribal Colleges are accountable institutions, always striving to be more accountable to our fenders, our students, and our communities. Several years ago, AIHEC launched an ambitious and landmark effort called "AIHEC AIMS," which is a comprehensive data collection system for TCUs, created by tribal college faculty and presidents, community members, funders, students, and accrediting agencies, aimed at improving our ability to measure and report our successes and challenges to our key stakeholders. Today, each Tribal College reports annually on a comprehensive set of 116 qualitative and quantitative indictors allowing us, for the first time, to share the true story of our success with funders, and most important, with our communities.

Tribal Colleges have advanced American Indian higher education significantly since we first began four decades ago, but many challenges remain. Tribal Colleges are poor institutions. In fact, Tribal Colleges are the most poorly funded institutions of higher education in the country:

(1) First: Tribal Colleges are not state institutions, and consequently, we receive little or no state funding. In fact, very few states provide support for the non-Indian students attending TCUs, which account for about 20 percent of all Tribal College students. However, if these students attended a state institution, the state would be required to provide the institution with operational support for them. This is something we are trying to rectify through education and public policy change at the state and local level.

(2) Second: the tribal governments that have chartered Tribal Colleges are not among the handful of wealthy gaming tribes located near major urban areas. Rather, they are some of the poorest governments in the nation. In fact, three of the ten poorest counties in America are home to Tribal Colleges.

(3) Finally, the Federal Government, despite its trust responsibility and treaty obligations, has never fully-funded our primary institutional operations source, the Tribally Controlled Colleges & Universities Act. Today, the Act is appropriated at about $5,784 per full time Indian Student, which is less than half the level that most states fund their institutions.

To continue to thrive and expand as community-based educational institutions, Tribal Colleges must stabilize, sustain, and increase our basic operational funding. Through tools such as AIHEC AIMS, we hope to better educate the public, lawmakers, and Federal officials about the cost-effective success of our institutions. Through opportunities such as this, we hope to share with the Congress and others how we are helping to meet the challenges facing our tribal nations.

TRIBAL COLLEGE STEM PROGRAMS: THE SIGNIFICANCE OF NSF–TCIIP

Although Tribal Colleges and Universities have made unprecedented strides in addressing the higher education needs of American Indians, much work and many challenges remain.

Of all groups in the U.S., American Indian students have the highest high school drop-out rates in the country. A 2010 report published by the Civil Rights Project/Proyecto Derechos Civiles at UCLA's Graduate School of Education and Information Studies revealed that less than 50 percent of all American Indian high school students actually graduate. If these students eventually pursue higher education, it is most often through the Tribal Colleges, which like other community colleges are open-admission institutions. In addition to offering a significant level of GED preparation and testing, Tribal Colleges face challenges with remediation and developmental education. On average, more than 75 percent of all TCU students must take at least one developmental course, most often pre-college mathematics. Of these students, our data indicates that many do not successfully complete the course in one year. Without question, a tremendous amount of TCU resources are spent addressing the failings of the K–12 education systems.

For this reason, TCUs have developed strong partnerships with their K–12 feeder schools are actively working, often through their NSF–TCU programs, to engage young students—early on and consistently—in community and culturally relevant science and math programs.

Because of the challenges TCUs face in engaging under-prepared students in STEM, improvement and innovation in science and mathematics education programs have been areas of great interest to most Tribal Colleges. However, the challenges to successful delivery of comprehensive STEM programs at the TCUs are also significant. Prior to NSF–TCUP, most Tribal Colleges were unable to secure the resources needed to build high quality STEM programs because we were not able to compete successfully in existing STEM programs sponsored by NSF and the U.S. Department of Education—most likely because we lacked the required Ph.D.-level principal investigators, could not demonstrate the "impact numbers" because of our size and remote locations, or simply could not afford the professional grant writers available to the much larger and fully resourced mainstream institutions.

Beginning in Fiscal Year 2001, NSF–TCUP changed this by making available essential capacity building assistance and resources to Tribal Colleges, either through direct funding or by leveraging funding from other sources. In fact, in less than ten years, NSF–TCUP has become the primary Federal program for building STEM capacity at the nation's Tribal Colleges and Universities. NSF–TCUP has served as a catalyst for capacity building and change at Tribal Colleges, and the program can be credited with many success stories, as detailed below. In fact, in terms of impacting enrolled members of federally recognized Indian tribes, the only data on the success of American Indians in higher education, and in STEM degree programs in particular, is collected by Tribal Colleges and Universities.

In implementing NSF–TCU programs, Tribal College administrators have attempted to take a broad view and systemic approach to their STEM needs, maximizing the return on NSF's investment through leveraging support from foundations and other Federal programs. TCUs now have greater capacity to address the STEM education and research needs of the tribal communities they serve in holistic and culturally relevant ways, which have been shown to increase retention and completion. More American Indians are entering STEM education and more are entering STEM professions, as demonstrated by enrollment and completion increases of 200 to 300 percent or more in some cases. STEM faculty are becoming more effective and engaged STEM instructors and researchers. Students are becoming more engaged, and with guidance from their faculty, they are becoming involved in cutting-edge and community-relevant research in significantly greater numbers. Classrooms and laboratories are better equipped. American Indians are more aware of the importance of STEM to their long-term survival, particularly in areas such as climate change. Partnerships between TCUs and major research institutions are emerging in areas of education and research, including pre-engineering.

Examples of successful STEM programs at the Tribal Colleges, funded by the NSF–TCU program, include:

Sitting Bull College, Fort Yates, North Dakota

- Established BS programs in Environmental Science and Secondary Science Education
- Enhanced student recruitment and retention efforts
- Created numerous student research opportunities
- Integrated traditional knowledge in STEM instruction

Outcomes

- 20 student research projects presented at scientific conferences; prior to NSF–TCUP funding, no presentations had been given by students
- Dramatic increase in average STEM enrollment: *tenfold* increase since 2004 (from 3 students to an average of 30 students)

Lac Courte Oreilles Ojibwa Community College, Hayward, Wisconsin

- Providing scholarships to STEM majors
- Improved access to STEM courses through alternative teaching modalities (e.g. distance learning)
- Incorporated Ojibwa traditional ecological knowledge into 41 courses to improve STEM literacy and establish cultural connections with STEM disciplines

Outcomes

- Realized a significant improvement in student retention (**88% retention** for scholarship recipients)
- 380% increase in STEM courses offered online, reflecting burgeoning demand on the part of students

Sisseton Wahpeton College, Agency Village (Sisseton), South Dakota

- Established a Computer Science and Technology degree program
- A BS degree program in Information Technology is being submitted for accreditation
- Partnering with area K–12s on a mathematics literacy program
- Providing professional development opportunities for STEM faculty and staff

Outcomes

- Establishing a local resource pool of trained computing professionals where there had been none before
- Reducing number of high school graduates requiring remedial math courses
- Providing a strong general science curriculum that is preparing students to pursue STEM fields of study

Turtle Mountain Community College, Belcourt, North Dakota

- STEM enrichment programs offered at area K–12 schools
- Expanded STEM course offerings, supplemented with computer aided instruction
- Developing an environmental science degree program
- Establishing research partnerships with four-year institutions

Outcomes

- Traditional ecological knowledge-centered outreach activities motivate area students to pursue STEM at TMCC
- 300% increase in STEM graduates
- Significant increase in the percentage of STEM majors at the college

College of the Menominee Nation, Keshena, Wisconsin

- Acquired/upgraded science and physics labs on main and branch campuses
- Hired Ph.D. level SIEM faculty to develop and offer new programs
- Established new Materials Science and Pre-Engineering programs
- Established successful STEM Scholars and Leaders student retention programs

Outcomes

- Menominee students have access to a variety of high quality STEM programs with good career potential
- CMN is developing high quality research programs
- STEM programs are achieving high levels of student retention and transfer

Fort Berthold Community College, New Town, North Dakota

- Establishing an Elementary Teacher Education Program with an emphasis on Math and Science
- Working with area middle and high schools to improve student enrollment in STEM courses
- Encouraging student transfer to Baccalaureate programs in STEM
- Established student research program

Outcomes

- Improved preparation of incoming freshmen in SIEM

- Significantly increased number of students majoring in STEM and continuing on to four-year institutions to pursue BS and advanced degrees

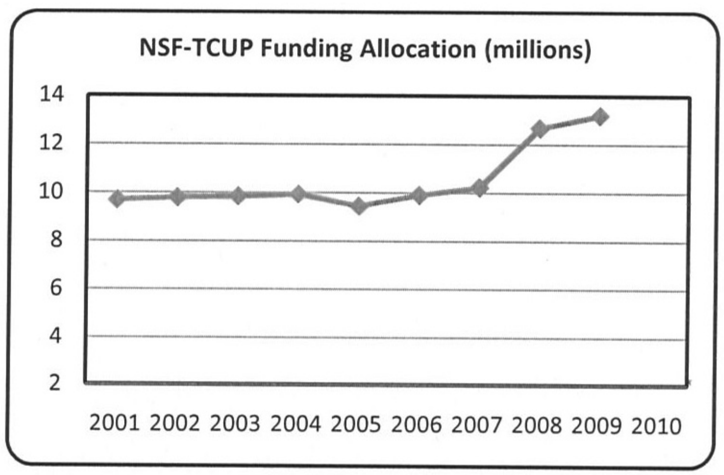
Oglala Lakota College, Kyle, South Dakota

- Established high quality online STEM courses
- Acquired state of the art science labs
- Providing K–12 STEM teacher professional development
- Established research collaborations with South Dakota universities

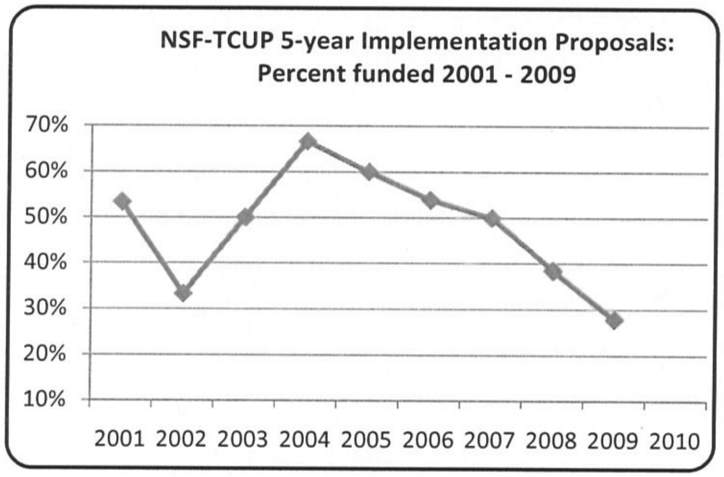
Outcomes

- Established a tribal STEM workforce in environmental science with graduates working in tribal agencies responsible for land and resource management, water quality, among others
- Improved quality of STEM instruction in area K–12 schools
- Conducted locally relevant environmental research

Despite the success of the NSF–TCU program and its demonstrated impact on American Indian STEM participation, we believe that the program must have increased support from the Administration and the Congress. We need such a commitment as we work to address the growing technology, science, and math crises facing our communities. The need for increased funding for the NSF–TCU program is well documented. In fact, between 2001 and 2007, NSF–TCUP funding was essentially static, as it has been again since 2008.



Further, since 2004, the percentage of proposals funded has declined each year, reaching an all-time low in 2009.



In 2009, less than 30 percent of all proposals were funded, out of a pool that includes only 33 eligible Tribal Colleges and Universities.

Clearly, the need for STEM-related funding at TCUs is not being fully addressed by available funding.

SYSTEMIC CHALLENGES TO BROADENING PARTICIPATION

We believe that the National Science Foundation and NSF–TCUP, in particular, could serve as a model for how Federal agencies could support strategies to alleviate institutional and cultural barriers to broadening participation of students pursuing science, technology, engineering, and mathematics (STEM) degrees and professions. However, outside of the NSF–TCU program, significant barriers to participation still exist and NSF's "broadening participation" effort has not been entirely successful. In fact, in some cases, it has had the effect of doing harm to Tribal Colleges and adversely impacting American Indian STEM education, as mainstream institutions seek to improve their chances to be competitive in grant competitions.

Throughout our history, states and mainstream institutions have taken advantage of Tribal Colleges and our students, adding us to their grant proposals and including our students in their statistical reports, without ever speaking to us or even notifying us that we are being used help them secure funding. Needless to say, we rarely receive any funding, technical assistance, or outreach when these proposals are successfully reviewed and awarded, and traditionally, we had no way of knowing how NSF or the awardee dealt with the lack of TCU inclusion after the award was made.

Over the past several years, as NSF's broadening participation requirement has grown in importance, the number of proposals from mainstream institutions seeking to include Tribal Colleges—without our knowledge or only after the proposal is completely developed—has increased dramatically. In fact, the situation became so frustrating that in early 2008, the AIHEC Board of Directors, on which the presidents of all accredited TCUs sit, approved a motion urging Federal agencies to adopt a policy that that any proposal for Federal funds, which directly or indirectly names Tribal College(s) or AIHEC in the proposal, but is not submitted by a Tribal College or University or AIHEC, must include documentation confirming that Tribal College administration or AIHEC, as relevant, is fully informed of and supports the college's role in the proposed project. The goal of this motion is to ensure that fewer proposals are funded that include TCUs without our knowledge or agreement and therefore fail to address the TCU priorities in a manner that is likely to prove successful, or whose project budget fails to include the resources necessary for the TCU to accomplish stated goals.

I am pleased to report that in the last year or two, we have noticed an increasing awareness among NSF program officers about the need for Tribal Colleges to be truly engaged as partners in proposal preparation and program implementation. We can cite specific examples, including one situation this year, in which a proposal was submitted by a researcher at a mainstream institution to provide STEM faculty and student development involving Tribal Colleges, but without any indication of input from the TCUs and certainly without any expressions of support. The researcher contacted AIHEC only after the NSF program officer specifically told the researcher to reach out to TCUs. Clearly, NSF's internalization of its broadening participation commitment has led to an increased awareness by program officers, and we believe this was a key factor in the program officer's directive to reach out to the TCUs.

Other Current Realities.

According to faculty and administrators at the Tribal Colleges, TCU faculty simply are not competitive in NSF-sponsored grant competitions, when compared to research faculty at major universities. Heavy teaching loads, responsibilities to other institutional programs, and obligations to participate in community activities severely limit the time TCU faculty have to write proposals, conduct research, and develop manuscripts for publication. Further, the institutions themselves lack the funding needed to hire experienced researchers and adequate support staff, including grant writers and assessment professionals. (See "Background" above on funding levels.) One TCU faculty member testifying before the NSF's Committee on Equal Opportunities in Science and Engineering stated that her institution had applied for an NSF grant outside of the NSF–TCU program on three occasions, at the recommendation of the NSF program officer. However, the project was not funded, despite high peer review scores and a demonstrated need, because the TCU lacked an adequate Ph.D.-level faculty member to serve as principal investigator in the Native science research.

Another problem facing TCUs is the size and remoteness of our rural institutions. These factors are often viewed negatively when panelists review TCU grant proposals and when we begin potential partnership negotiations with faculty members from larger universities. "How many students are they going to be able to affect?" is a common question, one TCU faculty reports. His response to this question is, "How many Native American students are in your science programs?" The answer is typically 1–3 students, based on self-reporting. The faculty member's institution, Sitting Bull College in Fort Yates, North Dakota, enrolls nearly 30 American Indian students in the Environmental Science program alone. Without NSF–TCUP, these students would not have been reached.

We are often told that TCU proposals are eliminated from competition by panelists and program officers who do not understand the unique situations of Tribal Colleges and our students. We are trying to build a community, not just a single program. Many of our efforts focus on developing basic math, science, and writing skills, along with showing students that opportunities they never dreamed of are possible, but only to the extent that we can be successful in securing funding.

RECOMMENDATIONS

RECOMMENDATION ONE: ***Maintain and increase targeted funding for Tribal College and University STEM Infrastructure, Education, and Research Programs.***

Given NSF's proposal in the Fiscal Year 2011 budget to eliminate the TCU program and instead offer one program for several different types of minority-serving institutions, our first recommendation is to maintain this vitally needed program, and to the extent possible, provide increased funds to ensure equitable participation by all TCUs. We believe it is important to note that NSF's decision was made without publically providing any research or analysis in support of the proposal and without discussion or, in the case of tribally-charted institutions of higher education, without consultation.

We urge the Federal Government, led by the National Science Foundation, to show an authentic commitment to broadening participation in STEM by honoring this nation's commitment to build the infrastructure of *all* segments of the U.S. academic and research community. In our view, this is the only way to guarantee that ALL Americans, including the First Americans, can fully and actively participate in the effort to achieve our collective STEM education and research goals. Given the unique needs of Tribal Colleges and Universities, the government-to-government relationship between federally recognized Indian tribes and the Federal Government, the Federal Trust Responsibility, and the programs' demonstrated success and need, we believe that it is imperative to maintain and expand funding for the NSF–TCUP.

Historical Justification. In the early 1980s, just as Little Big Horn College was establishing itself in two old trailers and a barn, the National Science Foundation established the national supercomputing centers program because "American researchers were at a serious disadvantage for gaining access to leading-edge high performance computers when compared to colleagues from other countries or to [researchers in key Federal agencies.] NSF leadership recognized that the lack of a suitable infrastructure was hampering important basic research . . ..”

Congress infused NSF with resources, which funded the national centers, along with roughly 80 institutions of higher education. The foundation for today’s technology infrastructure was in place at key institutions of higher education, and academia was on its way to cyber-enhanced research and education.

But that world did not reach Crow Agency, Montana or Rosebud, South Dakota. Not one Tribal College was funded during those early days, nor for many subsequent years. No one from the tribal college community even participated in the discussions and debate in 1984, or later in 1994 when the program was up for reconsideration. And so, where are the Tribal Colleges today, vis-à-vis mainstream institutions and many Historically Black Colleges and Universities and hundreds of Hispanic Serving Institutions (and even the state-supported Native Hawaiian and Alaska-Native serving institutions)? Today, our institutions are where these groups were in their early developmental days, before the infusions of Federal funding. How do our institutions get to where other institutions are today, so that we can begin to compete on an even playing field? The same way the other institutions did: through support and collaboration with Federal agencies, led by the National Science Foundation, and through collaborations with other institutions of higher education around this country and the world.

Tribal Colleges, no less than any other institution, deserve the opportunity to grow. We should, and must, be part of the future of technology-mediated STEM education and research in this country and the world. And if inclusion means that funding must be dedicated to help the Tribal Colleges and other minority serving institutions build their infrastructures, then it must be done, just as it was in the past for others. They demanded no less. Why should we?

If this is not done, TCUs will continue to be missing from the list of institutions participating broadly in NSF programs. “Broader participation” will apply to all but reservation-based American Indians and their tribally-chartered institutions of higher education. We know that this will be the case because today, most if not all, TCUs are unable to successfully compete in NSF programs beyond TCUP, primarily because of a lack of understanding and serious consideration by program officers and peer reviewers, as described above.

RECOMMENDATION TWO: ***Length and Focus of NSF–TCUP Awards***

Given the limited pool of TCU applicants (33 accredited TCUs) and the need to build—often from the ground up—and sustain S I EM programs for a length of time deemed sufficient to achieve improvement at all levels, NSF should be directed to:

1. Make grants under the NSF–TCU program for a period of ten years, or alternatively, five years, with ongoing support for an additional five years (without the need to re-enter a program competition), provided the programs meet appropriate NSF criteria for satisfactory progress; and
2. Refrain from expanding or prioritizing purposes within the NSF–TCU program in new areas (e.g. K–12 teacher education, which previously had been supported by NSF under the Urban and Rural Systemic Initiatives) until sufficient funding exists to meet the basic STEM needs of TCUs and reliable data demonstrates a significant improvement in basic STEM education participation and completion rates across TCUs.

We recognize that a need exists to address STEM education at all levels. However, funding is severely limited under the NSF–TCU program—it has not grown significantly over the years. Therefore, should NSF personnel believe that additional areas need to be addressed or additional programs established, beyond those proposed by TCUs under the general NSF-TCU program, new funding should be requested or designated, rather than reprogramming funds appropriated for vital basic STEM education and research programs. This is particularly important when the new funding priorities established under programs such as NSF–TCUP would replace programs eliminated elsewhere within NSF.

Under the existing NSF–TCUP, funding should be permitted to address critical areas of need, including:

- Research and development of culturally relevant STEM curriculum, for all grade levels, including in Native languages;
- STEM outreach and partnerships among TCUs and K–12 feeder schools and 13–16 programs/institutions to ensure seamless pathways into STEM professions

- Best practices in addressing gateway and bottleneck courses that are necessary for students pursuing STEM degrees and professions
- Innovative and collaborative curriculum development
- Comprehensive student support services
- Faculty development and support
- Acquisition of laboratory equipment/instrumentation
- Acquisition and application of emerging technologies
- Expansion of undergraduate research capacity and opportunities
- Partnerships with other institutions of higher education, including mainstream and MSIs, for research and technology assistance (possibly using the AN–MST model, which was a project funded by NSF to EDUCAUSE, involving the three primary MSI communities)
- Increased technical assistance and project management assistance for awardees, as explained above.

RECOMMENDATION THREE: ***Take steps to ensure that proposals and programs impacting Tribal Colleges and their students include adequate consultation and partnerships***

We request assistance in enforcing and measuring compliance with a requirement that any collaborative proposal involving TCUs in which a non-TCU is the lead institution must include, among the supporting documents, letters of support and commitment from the TCU signed by an authorized representative of the institution or the American Indian Higher Education Consortium. (For more information, please see Attachment A).

RECOMMENDATION FOUR: ***Consider re-invigorating the NSF's "Rural Systemic-Tribal College Initiative" or establishing a new grant program to increase partnership opportunities between TCUs and 5–12 schools and programs***

In the 1990s, through the National Science Foundation's Tribal College Rural Systemic Initiative (TCRSI), 20 TCUs partnered with their local school districts to achieve successful and sustainable improvement of STEM programs at the K–14 level. Founded on the assertion that all students can learn and should be given the opportunity to reach their full potential, Tribal Colleges led the effort to achieve "whole system change." Parents, tribal governments, schools and the private sector are working with the colleges to:

- Implement math and science standards-based curriculum for all students;
- Implement math and science standards-based assessment for all schools;
- Implement math and science standards-based professional development for teachers, administrators, and community leaders; and
- Integrate local Native culture into math and science standards-based curriculum.

The close working relationship between the TCUs and K–12 schools was paying off, according to the National Science Foundation, which reported that successful systemic reform had resulted in:

- Clear evidence that the program is significantly enhancing student achievement and participation in science and math;
- Significant reductions in the achievement disparities among students that can be attributed to socioeconomic status, race, ethnicity, gender, or learning styles;
- Implementation of a comprehensive, standards-based curriculum aligned with instruction and assessment, available to every student served by the system and its partners.
- Convergence of all resources that are designed for or that reasonably could be used to support science and math education—fiscal, intellectual, and material—both in formal and informal education settings—into a focused program that upgrades and continually improves the math and science program for all students.
- Broad-based support from parents, policy makers, institutions of higher education, business and industry, foundations, and other segments of the community for the goals and collective value of the initiative.

Despite its demonstrated success, the program was terminated some years ago. This is the type of program that should be reinvigorated and strongly supported by the Congress and NSF.

RECOMMENDATION FIVE: ***Expand EPSCoR inclusion and encourage NSF to use a centralized approach to learn about the capacity and needs of Tribal Colleges & Universities***

Over the past few years and as a result of changes in law and policy, senior level NSF administrators have begun developing strategies to better serve TCUs and American Indians. For example, in FY 2010, the NSF's Engineering Directorate committed funds to TCUP to support pre-engineering activities at TCUs. Following long-needed changes in program requirements, EPSCoR programs are finally beginning to include TCUs in state-based programs in more meaningful ways. Although several EPSCoR states are home to TCUs, North Dakota and New Mexico have taken notable steps to include TCUs. For the past few years, the North Dakota EPSCoR program has allocated funding to support a statewide Tribal College liaison, although the liaison is housed at the state university rather than a TCU, and it is providing relatively limited program funding to support EPSCoR activities at TCUs in the state. Recently, we have been told that NSF's Biology Directorate has been developing strategies to outreach to the TCUs. While we are encouraged by this effort, we respectfully suggest that the National Science Foundation could be more effective if it would work through our central organization, AIHEC, to discuss our needs and capacities and develop realistic outreach strategies. Approaching TCUs through a centralized source and capitalizing on the expertise of our Board's STEM Committee is a cost effective strategy for engaging our institutions.

A centralized model could also be used to coordinate a program whereby NSF would take the lead in developing and implementing a cross-cutting Federal initiative in which Federal agency officials and program officers spent a summer (or equivalent time period) in Indian Country and serve as mentors to STEM programs at TCUs and Indian-serving K–12 schools.

RECOMMENDATION SIX: ***Encourage coordination and leveraging of various NSF programs to help build TCU capacity***

We believe that NSF should launch a coordinated effort to empower and encourage TCUs to link programs and opportunities to better meet the needs of American Indian students. For example, NSF–TCU programs could be more effectively linked with EPSCoR, as discussed above, as well as the Louis Stokes Alliance for Minority Participation and other existing NSF-supported programs across Directorates. Further, the National Science Foundation could establish faculty exchange programs, among Minority Serving Institutions, as well as with faculty at mainstream institutions and national research laboratories.

RECOMMENDATION SEVEN: ***Technical Assistance for and about TCUs and new research involving the challenges confronting efforts to broaden participation among American Indians***

Based on a motion of the AIHEC Board of Directors, which comprises the presidents of all the nation's accredited TCUs, we recommend that any grants or contracts for technical assistance under the NSF–TCU program should be awarded to an Indian organization, which the NSF Director finds is nationally based, represents a substantial American Indian constituency, and has demonstrated expertise in Tribal Colleges and Universities and American Indian higher education. This will help ensure that the unique needs of TCU students, faculties, and institutions are addressed effectively and efficiently in a context that optimizes TCU-focused capacity building. We urge that technical assistance be provided to the TCUs so that we are more competitive in grant competitions, and that technical assistance be provided to NSF and other Federal science agencies to ensure that they understand and are responsive to the unique needs and characteristics of Tribal Colleges and Universities and American Indian students.

We also recommend that the National Science Foundation fund research examining the challenges to STEM engagement that American Indians face to STEM engagement, including a study to evaluate the capacity of the TCUs' physical infrastructure to support high quality STEM programs, research on underlying risk factors, and sociological studies designed to better understand the social dynamics impacting STEM education in Indian Country, and dissemination of best practices and model programs.

RECOMMENDATION EIGHT: ***Blue Ribbon Panel on MSIs and Cyberinfrastructure***

We believe it would be productive for the Congress to direct the National Academy of Sciences or the National Science Foundation to establish a "Blue Ribbon Panel on Minority Serving Institutions and Cyberinfrastructure," with the goal of producing a report and action plan for ensuring the active inclusion of minority serving institutions (MSIs, including TCUs, Hispanic-serving Institutions, and Historically Black Colleges and Universities) in Cyberinfrastructure development, research, and education programs. In addition, we recommend that Congress encourage or mandate each Directorate within the National Science Foundation to study and report on its efforts to engage American Indians in its programs.

We are grateful, Mr. Chairman, for this opportunity to share our story, our successes, and our needs with you today. We look forward to working with you to achieve broader participation in STEM degree programs and to achieve our nation's post-secondary education and STEM workforce goals. Thank you.

AMERICAN INDIAN
HIGHER EDUCATION CONSORTIUM

121 Oronoco Street • Alexandria, VA 22314 • 703.838.0400 • FAX: 703.838.0388

March 26, 2008

Deborah J. Cavett
Executive Director
White House Initiative on Tribal Colleges and Universities
1990 K St., N.W. Room 7010
Washington, DC 20006

Dear Ms. Cavett,

On behalf of the nation's 36 Tribal Colleges and Universities (TCUs), which comprise the American Indian Higher Education Consortium (AIHEC), I am writing to voice an ongoing concern regarding federally funded collaborative projects involving TCUs and other higher education partners, in which the tribal colleges play a minor, and often token role. Over the past several years, we have encountered an increasing number of cases in which one or more tribal colleges is included in a proposal, either without any real participation on the part of TCU academic administrators in the planning process, or in some cases without actual knowledge about the project proposal prior to submission.

We understand that most federal grant programs make an effort to support proposals that are likely to have an impact on underserved populations. We believe that this priority has led to a situation where TCUs are sometimes used to demonstrate the project's "broader impact" for the benefit of the reviewers. However, if the proposal is ultimately funded, project activities often fail to address priorities of the tribal college in a manner that is likely to prove successful, or the project budget fails to include the resources necessary for the TCU to accomplish stated goals.

The tribal colleges have strong partnerships among mainstream higher education institutions that have led to positive programmatic outcomes for all institutions involved. However, an attitude exists among some institutions that tribal colleges can be exploited for their status as minority serving institutions, with little need to work with them as equal partners.

To address this concern, we respectfully request that the following policy be established within all federal grant programs: *Any collaborative proposal involving TCUs in which a non-TCU is the lead institution must include, among the supporting documents, letters of support and commitment from the TCU signed by an authorized representative of the institution (e.g. the president, chief academic officer, or director of sponsored programs).*

Although this measure alone is not likely to rectify this problem, it will help limit some of the more excessive abuses the tribal colleges have experienced. This request results from a motion passed by the AIHEC Board of Directors, on which the presidents of all accredited Tribal Colleges and Universities sit, at our Spring 2008 Board meeting in Bismarck, ND. The motion is as follows:

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MOTION: That the AIHEC Board of Directors requests that the White House Initiative on Tribal Colleges and Universities (WHITCU) urge all federal departments and agencies to require that any proposal for federal funds (in response to a Request for Proposals or "RFP"), which directly or indirectly names tribal college(s) or AIHEC in the proposal, but is not submitted by a tribal college or university or AIHEC, must include documentation confirming that tribal college administration or AIHEC, as relevant, is fully informed of and supports the college's role in the proposed project. Further, the Board directs AIHEC staff to prepare and send a letter to all federal departments urging the adoption of the policy set forth above.
OUTCOME: The motion was agreed to by voice vote.

I am confident that you will work with federal agencies to address this important issue, and I thank you for your attention to our concerns. Please do not hesitate to contact me should you have any questions.

Sincerely,

Cheryl Crazy Bull

Cheryl Crazy Bull
Chair, AIHEC Board of Directors and
President, Northwest Indian College

Sisseton Wahpeton College

To: Carrie Billy, President of AIHEC
From: Diana Canku, President of SWC
Subject: NSF-TCUP
Date: March 12, 2010

The National Science Foundation's (NSF) *Tribal Colleges and University Program* has been vital to the growth of the Sisseton Wahpeton College in the area of STEM education. The original TCUP award was funded in 2004, and concentrated on the development of a Computer Science and Technology (CST) degree at SWC. During that time SWC graduated ten students from the program, and over fifteen students are working in the field, primarily at tribal agencies or businesses.

SWC has developed the curriculum for a bachelor's degree in IT, which is being submitted to the Higher Learning Commission for approval. This would be the college's first four-year degree program. TCUP also provided funding for our CST instructor to complete his master's degree. Additional information is provided in the attached files.

In the fall of 2009, the National Science Foundation awarded SWC with a second TCUP grant. This project is in the very early stages, but is already showing great potential. SWC is working in partnership with two of the tribal K-12 schools, and two public schools on the reservation to improve mathematic literacy. This will included the possibility of dual credits for the advance students. SWC is also negotiating a new articulation agreement with South Dakota State University as the college develops a new Sustainable Environmental Studies degree program.

One of the greatest impacts that NSF has had at SWC is capacity building. While every federal agency requires a high level of accountability, NSF has been at the forefront in providing assistance to the tribal colleges in developing this capacity. The small, program specific conferences, such as the TCUP Leader Forum, have been very productive, especially for new PI/PDs. Additionally, the grants funded by NSF to provide professional development for PI/PDs demonstrate a commitment to success after an award is made. The recent initiatives by the Engineering and BIO directorates provided tribal colleges a unique opportunity to be heard prior to the development of programs targeting our institutions.

Programs like the NSF-TCUP are instrumental to the continued growth of small tribal colleges, such as SWC. It is extremely difficult to compete with the larger institutions, such as some of the Native Hawaiian serving institutions that currently eligible in TCUP. If this was expanded to all minority serving institutions (MSI) most of the small tribal colleges would be shut-out of the competitions.

Sisseton Wahpeton College

State universities with a small number of Native American students would be able to apply for funding stating that they would serve the needs of the reservation. Unfortunately, this rarely happens in reality. Only two years ago a major NSF award was made to a state university that listed SWC as a partner institution. No one at our college approved of, or even was aware of this "agreement". This decision could easily make this situation common place once again.

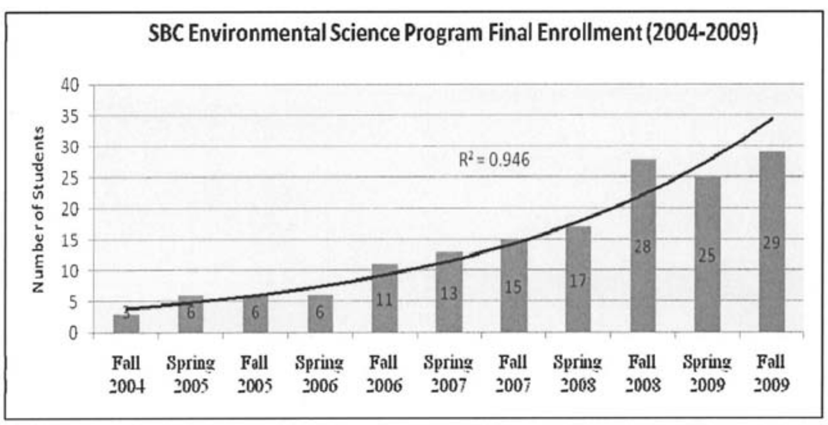
One only need look at the history of awards made by NSF over the last several decades to see the value of programs like NSF-TCUP to the tribal colleges. During that time period only a handful of awards were made to tribal colleges from other Directorates; about eight from the BIO Directorate, and few others in other programs such as ATE. A similar case is what happened with the Department of Defense grants.

It has also been extremely valuable to have program officers who are knowledgeable about tribal colleges. Reviewers often comment on the small number of students, the lack of grant experience perspective principal investigators have, the lack of tenure for senior personnel. One proposal submitted to the Informal Science Education program was marked down for the lack of student numbers, although it included every 8th to 12th grader in a thirty mile radius. A different outreach proposal was in part rejected because a reviewer did not understand that the K-12 computer classes are not taught by teachers with computer science backgrounds. Programs like NSF-TCUP, and their program officers, understand these realities. Unfortunately, this proposed change would make it very difficult for small tribal colleges to receive awards that have the greatest impact on these most vulnerable students.

Please contact us if you need any further information.

Sitting Bull College
Fort Yates, North Dakota
National Science Foundation: SBC-TCUP Program
March 2010

The overall goal of Sitting Bull College's National Science Foundation-Tribal College and University program (SBC-TCUP) is to increase the number of Native American students completing STEM degrees. The SBC-TCUP project is designed to develop science programs by integrating culture, developing student research opportunities, and enhancing recruitment and retention programs. Our successes have been built on a theme of community involvement and undergraduate research. The TCUP program has been very successful in increasing enrollment and number of graduates in our primary degree program (Environmental Science) and in STEM programs throughout the institution. Since TCUP implementation in 2004, we have added our first B.S. science programs in Environmental Science and Secondary Science Education. In our initial graduating class from the B.S. Program, two students entered graduate programs at Montana State University and University of New Hampshire, one student is a full-time biologist with an environmental consulting firm, and the final student is lead laboratory technician at the SBC Analytical Lab. Since 2007, more than twenty student research projects have been presented at scientific conferences, with several students receiving Best Paper or Poster awards. Prior to TCUP implementation, no presentations were given at external meetings. Most importantly, the TCUP program has helped to build a research culture within the institution and has developed a foundation of collaboration with other federal, state, and Tribal agencies.



Justification for maintaining a separate TCUP program:

SITTING BULL COLLEGE
FORT YATES, NORTH DAKOTA
NATIONAL SCIENCE FOUNDATION: SBC-TCUP PROGRAM
March 2010

We, as Tribal College faculty, are not competitive when compared to research faculty at major universities. Heavy teaching loads, heavy commitment to institutional committees, and maintaining community ties severely limits the time we have to write proposals, conduct research, and develop manuscripts for publications. But, our strategies for mentoring undergraduate scientists is exceptional and is beginning to show profound outcomes (students going to STEM graduate programs, presentations at scientific conferences, publications in scientific journals) for our students. The NSF-TCUP program is unique in the type of colleges that it serves. HBCUs and HACU-member institutions include many large and prominent universities with full support staffs including grant writers, assessment professionals, and hordes of established scientists on which to build a proposal.

The size of our institutions based on enrollment is often a detriment when panelists review our proposals or in informal discussion with faculty members from larger universities. "How many students are they going to be able to affect?" is a common question. My response to this is: "How many Native American students are in your science programs?"—the answer is typically 1-3 students. SBC has almost 30 Native American students in the Environmental Science program alone. Without NSF-TCUP, these students would not be reached.

Having served on several review panels, proposals can be eliminated from competition by a panelist or a program officer that does not understand the unique situations of Tribal Colleges and the unique situations of our students. We are trying to build a community, not just a program—many of our efforts go to developing basic math, writing, and speaking skills and showing students the opportunities that exist beyond their doorstep.

Tribal Colleges have suggested several times that a 5-year program is not enough to show the kind of progress that NSF expects, because of the reasons discussed here. Progress and measurable outcomes are being obtained and, as the graph above suggests, we are on course for dramatic, exponential success in our programs. Elimination of the TCUP program will have dramatic effects on our programs and the ability of our current students who are looking forward to continuing on to graduate programs in the near future.

OGLALA LAKOTA COLLEGE
KYLE, SOUTH DAKOTA
MARCH 2010

Overview of the Oglala Lakota College TCUP Program

By Charles Jason Tinant, jtinant@olc.edu
Dr. Hannan LaGarry, hlagarry@olc.edu
490 Piya Wiconi Road
Kyle, South Dakota 57752

Overview

Oglala Lakota College (OLC) has benefited significantly from the National Science Foundation's TCU program over the last decade. The NSF-TCUP has been instrumental in developing a high quality math and science curriculum at OLC. Through the development of infrastructure and personnel, we have recently begun to develop collaboration opportunities with universities in South Dakota and elsewhere. At present, because the poverty of the Pine Ridge reservation we do not have a tax base to support our institution and, because of the ten year period in which we have had science degree programs, we are not competitive with South Dakota universities. We have major concerns that the proposed changes to TCUP funding will significantly limit our ability to continue to grow our infrastructure and our faculty. The most likely scenario, if the proposed changes were to take place, would be that that OLC would play a subservient role to South Dakota Universities, and the progress we have made in terms of TCU quality and effectiveness would erode over time.

We were asked by AIHEC for the following information: 1) provide a short description of your NSF-TCUP project, 2) discuss any great outcomes that you have experienced, and 3) provide recommendations for changing the current NSF-TCUP so that it better meets your needs, 4) give experiences in applying for grants with NSF outside of the TCU program (NSF-TCUP).

Short Description of our TCUP Projects

We currently have two TCUP projects at OLC, a TCUP Phase I project to develop an infrastructure for Earth Science and Conservation Biology so that we will begin to become competitive in research, and a STEEP project to fund the professional development of new and current K-12 teachers on the Pine Ridge Reservation.

Specifically, our TCUP Phase I project will build capacity in earth science, ecosystem science, chemistry, and the biological sciences through educational opportunities at the MS and PhD level for Tribal College faculty and teaching staff and through developing a data infrastructure to archive and disseminate results from past and current research projects on the Pine Ridge reservation to students, faculty, tribal programs, and other collaborators. This will: 1) strengthen educational and research relationships between a Tribal College, tribal resource programs, and mainstream universities to significantly increase the number of undergraduate students participating in research and service-learning, 2) provide informal science outreach to community members and K-12 schools,

OGLALA LAKOTA COLLEGE
KYLE, SOUTH DAKOTA
MARCH 2010

3) develop principal investigators at Tribal Colleges, 4) integrate classroom learning and summer research experiences at OLC, and 5) establish graduate level coursework at a Tribal College through a memorandum of agreement with a mainstream University.

Our STEEP program increases the number of qualified, high quality secondary teachers for Pine Ridge reservation schools. It trains them in effective methodologies and provides additional support in the form of teaching tools, software, and post-graduate professional development opportunities. The program continues to build on our K-12 outreach initiatives, and strengthen our collaborations with schools across the reservations of South Dakota. Over time, the program outcomes will have an impact on over 14,000 schoolchildren in our partner schools, 90% of whom are Native Americans. The ultimate goal is to eliminate the 35 percentage point gap between the SAT9 scores of Native American schoolchildren on the Pine Ridge reservation and their South Dakota counterparts.

Significant Outcomes

The OLC Math and Science department has used NSF funding through MIE and TCUP to develop infrastructure for distance education and research. As an outcome of MIE, greater than 80% percent of our courses are taught using synchronous distance education platforms (pictel) and greater than 40% of our courses use both pictel and internet-based asynchronous distance education. We have also established best practices and institution-wide distance education policies for courses taught in a fully asynchronous setting. Our first TCUP award provided resources to purchase research laboratory equipment including an atomic absorption (AA) flame and furnace, gas chromatograph mass spectrometer (GCMS), portable and benchtop x-ray florescence for elemental analysis, benchtop x-ray diffraction, ion chromatograph, and GIS remote sensing laboratory. A phase II TCUP award provided us with resources to catalyze relationships with tribal agencies. Our tribal partner agencies now see OLC and the Lakota Center for Science and Technology (LCST) as a credible science resource center that can help solve their problems. In 2009, OLC received a second TCUP phase I award to shift our focus from equipment acquisition to data acquisition by retaining our faculty to develop institutional memory, expanding our network of partnerships and collaborations, build community relations, and establish end points for long-term research through the integration of science education and reservation-centered undergraduate research emphasizing that meets the needs of our community members.

Our greatest successes have been our recent graduates. Until recently, our graduates had considered a BS in science as a terminal degree. However, as an outcome of TCUP funding, our recent graduates are enrolling in graduate school. These students are all first generation college students from poor families on the reservation. Many of these students had initially failed out of mainstream schools before attending OLC. Through TCUP, we have been able to mentor these students in a hybrid research and education program that has allowed them to develop professional skills and be competitive at a graduate school level.

Experiences in Writing Outside of NSF TCUP

We have been successful in being funded from outside of the Human Resources Directorate (HRD) two phases of a single project – the Lakota Land Project (details are given below), however we have not been successful with any other proposals. There are several reasons we have been unsuccessful over the last decade in having research funded by other NSF directives: 1) Tribal Colleges are primarily teaching colleges, and our faculty traditionally has not had release time to develop research projects, 2) the majority of our faculty is at the BS and MS levels and thus does not have research experience to be competitive, 3) NSF research proposals typically require hypothesis testing of baseline data, which does not currently exist for the Pine Ridge reservation.

GEO-0503612, $55134 7/15/2005-6/31/2006 (PI Dr. Sylvio Mannel). Lakota Land Mapping, culture, history, and recreation. In this pilot project we locate Lakota historical, cultural and recreational areas. Lakota Land includes establishing a geodatabase, setting up an online interactive map, supporting the formation of a committee to handle sensitive sites, and investigating links of Native sites with geospatial features.

GEO-0703813, $100,000 9/01/2007-8/31/2009 (estimated) (PI Dr. Gerald Giraud). Lakota Land 2 - Sharing Lakota History. This is a continuation of the NSF funded Lakota Land Project, which had students of the Oglala Sioux Tribe use modern GPS and GIS tools to map culturally important sites of the Pine Ridge Reservation. This continuation project focuses on sharing the mapping activities and historical information with partners and/or institutional participants, such as Alliance of Tribal Tourism Advocates (ATTA) and Oglala Lakota College's (OLC) TV Production Program, local youth organizations and other geospatial data users.

Recommendations

We feel the existing TCUP program (e.g the program as it existed prior to the proposed budget) well meets our needs. In terms of other NSF directorates, new programs targeted for undergraduate research and education would be areas that TCUs could become competitive in. These types of programs are needed if TCUs are to be successful outside of the NSF's HRD directorate.

Mini-Symposium – 2008 Report
Broadening Participation of Native Americans in Science and Engineering: Lessons Learned

A report submitted to the Committee on Equal Opportunities in Science and Engineering
by
Dr. Marigold Linton, CEOSE Member

October 29, 2008

The Mini-Symposium on broadening participation of Native Americans in science and engineering was held on October 29, 2008, at the National Science Foundation. It was designed to highlight strategies that increase the number of Native Americans in science and engineering. This activity was co-sponsored by the Committee on Equal Opportunities in Science and Engineering (CEOSE) and the National Science Foundation (NSF) Centers Forum, and it has assistance from The Mississippi eCenter in its development. It was well attended.

The goals were:

- To identify lessons learned and persistent barriers to broadening participation in science and engineering by Native Americans;
- To share ideas and experiences of leaders in the community, as well as those of officials at selected Federal agencies, on broadening the participation of Native Americans in science and engineering;
- To make recommendations to CEOSE on what actions it could take that would best propel the science and engineering agenda forward for Native Americans; and
- To make recommendations to CEOSE and to funding agencies (including NSF) on ideas for policies and programs that will cause institutions to choose to make changes, which taken together will transform the science and engineering enterprise to become much more welcoming, supportive, inclusive, enabling, and advancing of Native Americans who are traditionally underrepresented in science and engineering (and obtain the data to demonstrate this progress).

Dr. Wesley L. Harris, CEOSE Chair, set the tone for the mini-symposium and **Dr. Kathie Olsen**, NSF Deputy Director, welcomed everyone. **Dr. Margaret E. M. Tolbert**, the CEOSE Executive Liaison, discussed the format for the meeting and introduced the persons responsible of providing background information on the three main speakers.

Designated discussants enthusiastically participated in the deliberations on the topic of the mini-symposium, following presentations by the three main speakers whose names and presentation titles follow:

Where Are We and Why Aren't We There Yet?
Ms. Holly Pellerin
Coordinator
Earth, Water and Wildlife Track
National Center for Earth-surface Dynamics (NCED)
Fond du Lac Tribal and Community College
and

Tribal Elder, Fond du Lac Band of the Ojibwe

Tribal Indigenous Knowledge: The Science, Technology and Tribal Interface at CMOP
Mr. Roy Sampsel
Board Member, Institute for Tribal Government, Portland State University
Chairman, External Advisory Board, Center for Coastal Margin Observation and Prediction

Alaska Native Science & Engineering Program (ANSEP), Building a National Model for Excellence in Native American Higher Education Programs
Dr. Herb Schroeder
Associate Dean and Professor of Engineering
University of Alaska-Anchorage, School of Engineering
Executive Director, LSAMP Pacific Alliance
Executive Director, Indigenous Alliance for Engineering & Science Education
Executive Director, Alaska Native Science & Engineering Program (ANSEP)

The above three speakers were introduced by **Dr. Dragana Brzakovic** of NSF, **Dr. Marigold Linton** of CEOSE, and **Dr. Joan Frye** of NSF, respectively.

Dr. David R. Burgess, a former CEOSE member who currently serves as Professor of Biology at Boston College and as a Board member of SACNAS, kicked off the discussion session with the presentation of data and questions that stimulated thought and focused the deliberations.

Recommendations that resulted from the mini-symposium provided by individual discussants who participated in the roundtable discussion are as follows:

- **Ms. Carrie L. Billy**, J.D., President & CEO, AIHEC:
  - Provide SIGNIFICANT resources over a sustained time frame – (longer term grants i.e., 10 years)
  - Provide Access to best practices – widely disseminated and used by grantees and potential grantees.
  - Develop and implement Co-equal partnerships across NSF, addressing, and including all areas, including climate change/geo-sciences education and research.

  * NSF should focus on improving and expanding access to its programs—lead other agencies by example, not by trying to force collaboration. You will just get bogged down in meetings. We need action!
  * We need a TCU EPSCoR!

- **Dr. David R. Burgess**, Professor of Biology, Boston College; SACNAS Board Member:
  - A new program should be created to support the efforts of the colleges and universities graduating large numbers of American Indian/Native American science B.S. students.
  - In states that do not have Tribal Colleges, create new pre-college programs for colleges with large enrollments of American Indian/Native American students.

- **Dr. Diana Dalbotten**, Diversity Director, NCED/University of Minnesota – Twin Cities
  - Support the formation and sustenance of AISES chapters (and SACNAS) at universities, Tribal Colleges, high schools, etc. These matter to the students,

who get more support (social, psychological) there than any where else if the chapter is strong.
  - Find out how often lack of scholarships and other funding leads to school dropouts from STEM programs. I know this has been the case with many STEM juniors or seniors that I know.
  - Find a way to include non-academics (program managers, teachers, parents, elders) in the new development of new NSF programs, and on programs panel.

  We need better research on promoting math (best practices) with Native Americans, but emphasis on control groups and number only hampers this research - how do you get reliable numbers with small groups and informal programs?

- **Dr. Anselm G. Davis**, Executive Director, White House Initiative on Tribal Colleges and Universities:
  - Find ways to ensure that everyone working with American Indians understand the history of education in the life of Indians and make adjustments.
  - Continue to provide resources in the hands of Indian people, which will help self-determination effort.
  - Research the Rural Systemic Initiative, and duplicate it.

- **Dr. Willard Sakiestemwa Gilbert** – Professor, College Education, Northern Arizona University:
  - Seek collaborative efforts with national Indian organizations to help set the agenda for the STEM initiative at the National Indian Education Association. The National Congress of the American Indians and the American Indians Science and Engineering Society have already started this discussion.
  - Find more programs that address the issues of providing STEM programs at the elementary level that targets the integration of traditional language and culture (i.e. traditions, stories, values, language, and indigenous ways of knowing) into the existing science curriculum from K-12.
  - Providing funding a program for professional development in areas of teacher training in how to teach science and how to develop native cultural knowledge based on cultural – based curriculum.

- **Dr. Gerald Gipp**, Former NSF Program Officer & Former AIHEC:
  - The NSF Director should create an American Indian Initiative, which cuts across all Directorates.

    Mandates

    1a. Each Directorate should assess its current contributions to promoting pre-k-12 education and post-secondary education for American Indians.

    1b. Each Directorate should consider changes in their program authority to increase service to American Indian education.
  - NSF should take a lead role to advocate for coordination with other federal agencies to create real partnerships (pre-k-12 – HE).

- **Dr. Marigold Linton**, Director American Indian Outreach, University of Kansas
  - Think of ways to improve grant writing and review.
    - ✓ Grant proposals are too often rejected on technical grounds rather than on the quality of the ideas.

  - ✓ The number of Native reviewers should be increased – both scientists and participants.

- **Dr. J.V. Martinez**, Senior Advisor, Scientific Institutional Outreach, Office of Science/US Department of Energy:
  - Fund a sociology-based study to understand the social content re: STEM education in Indian country;
  - Re-institute Rural Systemic Initiative directed to TCU;
  - Conduct a study to evaluate infrastructure in TCU that hinders STEM education.
  - Catalog the more successful STEM education experience in TCU.

- **Dr. William E. McHenry**, Executive Director, The Mississippi eCenter/Jackson State University:
  - Provide a forum (on-line) to continue the discussion, which was begun with this mini-symposium.
  - Use technology to link Tribal Colleges with NSF funded projects to encourage transfer and BS Degree completion.
  - Link TCUP & LSAMP with STCs and other large Center programs at NSF to encourage – where possible – infrastructure development.

- **Dr. Gerald E. (Carty) Monette**, Senior Advisor, Quality Education for Minorities Network, Inc.:
  - Professional Development
    - ✓ TCU faculty
    - ✓ K-12 faculty

    Focused on STEM Instructional Improvement, and for TCU STEM faculty include research opportunities for undergraduate (STEM Learning).
  - Teacher Education
  - Use the TCUP as a vehicle for collaboration and partnership ventures with NSF among Directorates.
  - Climate change initiatives, instruction, and research.
  - Application of Technology to improve STEM instruction and research.
  - Provide project specific evaluations on Tribal College and University campuses; however, be sure that those who are conducting those evaluations are familiar with the Tribal Colleges and Universities.
  - Develop the evaluation capabilities of more Native Americans who can evaluate NSF projects.

- **Dr. Holly Pellerin**, Tribal Elder & Coordinator for Earth, Water and Wildlife Track of NCED, Fond du Lac Band of the Ojibwe:
  - Let us write what we need for STEM advancement and try to work with us to fill our needs, and it will fill our needs as people of our Earth. Include STEM.
  - Don't make us quibble over money or compete with other Indians.
  - Do what you mean for American Indians. Participation as real partners – not just "add ins".

- **Dr. Carl S. Person**, Manager, Minority University Research and Education Programs, Office of Education, NASA Headquarters:

- Recommend NSF consider a program designed to place scientists and engineers from across the country at TCUs. Individuals could spend up to two years conducting research and/or teaching at the Tribal Colleges.
- Recommend NSF take the lead in developing, planning, and implementing a crosscutting Federal Agency program focusing on internship and externship in which Federal representatives spend the summer in Indian country. Representatives from Federal Agencies would serve as mentors for cohorts of student and faculty teams involved in hands-on research. The goal is to involve them in research that they can continue their campuses with on-going connections to the visiting scientists or engineers.

- **Dr. Patricia Petite**, President, Fond du Lac Tribal College:
  - Community Outreach
    - ✓ Families – partnership
    - ✓ Schools P-12
    - ✓ Tutors - family nights (math and science)
  - Teacher Training
    - ✓ Re-train
    - ✓ Curriculum
  - Flexible Requirements
    - ✓ One size doesn't fit all.
    - ✓ Resources

- **Dr. Clifton A. Poodry**, Director, Minority Opportunities in Research Division, NIGMS/NIH:
  - Continue to gather data on the nature of the problem.

    Less than 50% American Indians graduate from high school.

    Half live on reservations.

    Are the high school and college graduates going rates different for reservation versus non-reservation Indians?
  - Is success over reported? Because identity is self-identified. Being an American Indian is not a race/ethnicity but a tribal affiliation – which varies by tribe.
  - The RSI clearly had an impact on K-12 and may be worth reviving.
  - Work with and through professional societies (e.g., SACNAS and AISES).
  - A very successful project for American Indian graduate students is the Sloan Program at the University of AZ. Form a partnership, and expand it.
  - Look to form a partnership with HHMI in its educational program. The Phage Discovery Project could easily be extended to TCU and to high school students.

  The concept of multi-generational grief is extremely important. Many families have several generations who have been failed by education systems. The effects of the boarding school days have been inherited and pass on to containing poor outcomes.

- **Dr. Paul E. Racette**, Co-Vice Chair, Goddard's Native American Advisory Committee, NASA Goddard Space Flight Center:
  - Establish guest faculty program at TCUs that draw professionals from government, industry, and academia. Benefits include:
    - ✓ Two way exchange,
    - ✓ Faculty relief,
    - ✓ Curriculum enrichment,

- ✓ Grant writing, and
- ✓ Increased understanding of cultural differences and strengths.

- Foster partnership between Native American communities, institutions, and faculty and government and industry. Foster partnering between federal agencies.
- Access the effectiveness of minority programs in reaching Native American institutions and students. Biases exist in the application, selection, and evaluation processes.

- **Mr. Roy Sampsel**, Chairman, External Advisory Board, CMOP/Oregon Health and Science University; Board Member, Institute for Tribal Government/PSU:
  - NSF should help other Federal agencies understand what the needs are in SET education and report to congress on the need for resources.
  - Develop long term funding that would be in the timeframe of five to ten years.
  - Understanding how complex the Indians/tribal world is so that NSF can address the full range of issues.

- **Dr. James Wyche**, Director, Human Resources Development Division/EHR/NSF:
  - Integrate the culture of native people with STEM education via NSF programmatic activities.
  - To improve sustainability, NSF should provide a minimum published time frame in which a teacher ed., student, or related preparation activities are supported.
  - Use best practice(s) of RSI to "re-model" a TCUP STEM activity to improve teacher/student education in native and tribal colleges.

- **Ms. Sara L. Young**, Director, American Indian Research Opportunities, Montana State University:
  - Continue dialogue with Native American programs and community leaders to create new programs that NSF can support in Indian country.
  - Strengthen the broadening participation requirements in all NSF funded projects – outside of the EHR divisions.
  - Provide incentives for STEM teachers and faculty to serve in reservation K-12 schools and tribal colleges who are struggling to hire STEM teachers and faculty.

Following remarks by **Dr. W. Lance Haworth**, Director of the Office of Integrative Activities of NSF, **Dr. Harris** advised that the above recommendations would be summarized for review and approval by members of CEOSE. The resulting summarized list of recommendations will be submitted by CEOSE to the NSF Director for action.

Biography for David Yarlott

David E. Yarlott, Jr. is a member of the Crow Tribe of Indians. He is a member of the Greasy Mouth Clan and also a child of the Greasy Mouth Clan. He also is a member of the Nighthawk Society. Dr. Yarlott's education began in the local Crow Indian Reservation primary schools and high school in Hardin, MT. He attended Little Big Horn College for several years before transferring to Montana State University-Bozeman, where he obtained his bachelor's and master's degrees in business and an Ed.D. in Adult, Community, and Higher Education. He earned an A.A. in Business Administration from Little Big Horn College. He obtained a U.S. patent on an invention, a tool used in suppressing grass fires.

Prior to becoming president, Dr. Yarlott served Little Big Horn College as Dean of Academic Affairs, Department Head of Business, Faculty Council President, Student/Faculty Representative to Board of Trustees, Faculty (business courses), advisor (American Indian Business Leaders, Student Bookstore, coordinator for the Johnson Entrepreneurship Grant, consultant (natural resources curriculum. For the Crow Tribe of Indians, he acted as liaison for Crow Tribal Forestry, director of Apsáalooke Nation Hotshot Crew (Developed), consultant for Economic Development and Planning, and president of the Montana Indian Fire Fighters Steering Committees. Dr. Yarlott work for the U.S. Forestry Service in the Gallatin National Forest for seven years and with the Bureau of Indian Affairs in forestry for 13 years. For ten years he worked the family farm.

President Yarlott is a member of the American Indian College Fund Board (AICF) (past chair), National Business Education Association (NBEA), American Indian

Higher Education Consortium (MEG) (current chair), National Indian Education Association (NIEA), Crow Economic Development Association, Hazardous Substance Research Centers, Montana State "Shared Leadership Committee,' NASULGC, USDAIAIHEC Leadership Group, and Montana Correctional Enterprise (appointed by governor).

He has received many honors, including TRiO Achiever Award (Regional)—ASPIRE; Award of Excellence—Montana State University-Billings; "Pathmakers"—one of five selected as outstanding Crow Members making a difference for the Crow People—LBHC; Achievement Award—Crow Nation; Accomplishment Award (Developing a Physical Fitness Program and establishing a Fire Engine Training Program)—USFS; Scott Hanson Memorial Award (For initiative, caring & leadership)—USFS; Business Scholarship (Graduate)—National Center (Mesa, AZ); Certificates of Appreciation for Outstanding Performances (three Years)—USFS; Phyllis Berger Memorial Scholarship—Montana State University; Outstanding Senior Native American Student—Montana State University; Grace Rosness Memorial Scholarship—Montana State University; and Harriet Cushman Memorial Scholarship (three Years)—Montana State University.

Chairman LIPINSKI. Thank you, Dr. Yarlott.

Ms. Craft.

STATEMENT OF MS. ELAINE L. CRAFT, DIRECTOR OF THE SOUTH CAROLINA ADVANCED TECHNOLOGICAL EDUCATION NATIONAL RESOURCE CENTER, FLORENCE DARLINGTON TECHNICAL COLLEGE

Ms. CRAFT. Chairman Lipinski, Ranking Member Ehlers, distinguished members of the Subcommittee, good morning. I am pleased to be with you today to provide a community college perspective on broadening participation in STEM. I have seen firsthand that when we are successful, business thrives, lives are changed for the better and personal financial success impacts entire families and the national economy.

Today I will share information about the two-year technical and community college environment in which I work, results from National Science Foundation funding that has broadened participation in STEM, changed lives for the better and supported economic development. I will also suggest a place in the academic pipeline that I believe is in need of major improvement if we are to hope to further broaden participation in STEM.

Community and technical colleges enroll more than 11 million students. We educate the most diverse students in higher education. We are the primary educators of highly skilled STEM technicians. These technicians are the Nation's first line STEM practitioners. They are critical to global competitiveness. Our country needs more technicians than it does scientists or engineers. The ratio generally ranges from three technicians to one scientist or engineer to sometimes as many as 12 to 15 technicians to one scientist or engineer. In this particular photo, you see Dr. Moira Gunn, host of the radio programs Tech Nation and Biotech Nation aired by National Public Radio with Willard Cooper. Willie is an engineering technology graduate of Florence Darlington Technical College [FDTC]. He now has a career as an engineering technician with ESAB Cutting and Welding in Florence, South Carolina. He was on the program with Dr. Gunn at an NSF Advanced Technological Education, or ATE, conference in Washington 18 months ago. Willie is married. He has four daughters. He is in the South Carolina National Guard. He was deployed to Iraq while he was in the engineering technology program. He returned to the program, graduated and now he has been tapped for officer candidate school in the National Guard and he has been deployed again, this time to Afghanistan.

Grant funding from the National Science Foundation has enabled us to prepare faculty to teach more effective ways using industry-type problems and teamwork. In this picture, you see technology gateway class of students who had to learn to use math, physics, technology and communications effectively to solve a problem and to build this model of their solution for a class presentation.

STEM programs at our institution support economic development. Graduates are ready for both the workplace and college transfer. Diversity in programs is improved with the NSF-funded initiatives. This photo is of Shelton Fort. He is a civil engineering technology student at Florence Darlington Tech. He has now graduated. He was working for an architect and he was designing the steeple on the church. You may able to see it on his computer monitor. He was justifiably proud of his work, but the big smile you see on his face is because he had just gotten engaged that day.

In addition to increased diversity, graduation rates soared with our NSF initiatives. Gains were attributed to placing an emphasis on retaining STEM students at the beginning of programs, where most dropouts occur. The graduation rates improved from 15 percent to 40 percent after we changed the way we taught the first year of our engineering technology courses. In this picture, you see Nateesa Clester Oliver. She completed a civil engineering technology degree at Florence Darlington Technical College. Her bachelor of science degree is in engineering technology at Francis Marion University. She is currently enrolled in a graduate program in project management at Brenau in Georgia.

African American success rates in engineering technology [ET] increased from 15 to 39 percent with our programs. The gains resulted from improving teaching methodologies that specifically addressed learning styles. Through teamwork and class and special activities for female ET students, underrepresented students experienced a sense of belonging. Meet Takeesha Boatwright. She completed a degree in computer science at Florence Darlington Tech and is currently completing her bachelor's degree in computer science at Coastal Carolina University.

Industry-sponsored student internships have been a big part of our program. Full-time enrollment and on-time graduation can be rare for community and technical college students who must work while attending college, and both are major retention factors. Industry-paid internships encourage full-time enrollment. Internships also augment learning. Broad economic benefit results when students transition from minimum-wage to high-wage employment. These students were working 40 hours a week making minimum wage. When they started their industry internships, they could cut back to 20 hours a week with the new high wages they were making. In this picture you see Shawn Jackson and Brad Tindell working at Honda of South Carolina where they make all-terrain vehicles and personal watercraft.

Scholarships promote on-time graduation, high grades and improved retention. We were able to reduce the time to graduation for our engineering technology students from 3.8 years to 2.2 years through a combined change in the way we taught our program and the scholarship support that allowed the students to be full time. The National Science Foundation supports our Tech Star scholarships through the S–STEM program [Scholarships in Science Technology, Engineers and Math]. To date, this program has a 95 percent graduation rate.

The story doesn't stop here. At FDTC, successful strategies and educational materials developed with NSF funding are now being used in 25 states and the District of Columbia. The ATE program, scholarships, and STEM programs at NSF have helped make this possible. In this particular slide, you will see some students at White County High School in Cleveland, Georgia. Through our partnership with the National Dropout Prevention Center at Clemson University, we are now looking at our teaching and learning strategies as dropout prevention strategies for high schools. The students you see in the picture were on the verge of dropping out of high school. They had already failed the science portion of the Georgia exit exam once and were not attending school regularly. We provided them with STEM-based hands-on projects that answer a question "why am I learning this" every day. They have had five cohorts in the program now. The success rate on the same exit exam in Georgia was 85 percent for the first cohort. They got 100 percent in the fall of 2009 with the fifth cohort.

Significant challenges remain in broadening participation. The two girls you see in this photograph attended our college's summer technology camp. What will happen to them? Will they be underprepared students? Will they struggle with success in STEM when they reach college? According to the ACT, in 2009 only 23 percent of our students graduating from high school that were tested were college ready. If they are underprepared, will they be disappointed to find that in our remedial programs that they are required to participate in, that that there is no relevant STEM in those courses?

Underrepresented students face non-academic and academic hurdles. First-generation students, when they attend college, may not understand that textbooks are no longer distributed by the district but have to be purchased and at high prices. They may not understand that there is no cafeteria that provides free or reduced-price lunches. They are on their own now, also, for transportation. And they haven't learned the habits of success. They didn't take rigorous high school science and math and they haven't been prepped to do well on placement tests when they come to the college as more advantaged students have been. The bottom line is, is that we are losing many potential STEM students after they enter college but before they actually begin their degree programs. Lengthy remediation that is not related to their major discourages program completion. This particular photo is a Hispanic engineering technology student named Dennis Olivares. His brother John is now a student in our program and is one of our Tech Star scholars.

The STE of STEM, science, technology and engineering, is needed much earlier in the college experience. Current practice in remediation omits these three important subjects.

Engineering technology students Patrick Cannon and Blake Wallace are working on a robot in class. Students not yet ready to enter the curriculum could benefit from similar experiences. The major challenge in broadening participation in STEM may be that underrepresented populations in STEM are most likely to also be underprepared for success in STEM. Community and technology colleges lack the needed resources and incentive to reform and ramp up these STEM programs. Science, technology and engineering faculty need to be involved and they are already a scarce resource in our institutions. Research-based teaching methodologies work. We have plenty of research that shows that. But faculty struggle to use teaching methodologies that were not the way they were taught. Faculty development is needed.

As outcomes from our NSF funding show, changes can be stimulated with targeted funding initiatives. The NSF ATE program has been a phenomenal catalyst for improvement in technician education nationally and should be used as a model for improving and infusing the science, technology and engineering into courses that address the needs of underprepared students. Done well, this could significantly broaden participation in STEM, perhaps more than any other single improvement in higher education.

Chairman LIPINSKI. Ms. Craft, if you can wrap up?

Ms. CRAFT. STEM success stories include the ones like the gal in the middle of this picture, Pamela Sansbury. Pamela was saved early. She came to the college, wanted to do cosmetology, said she wanted to do hair. We discovered she had math ability and directed her to engineering technology instead. Today, she is a national trainer for robotics manufacturer ABB, very successful, looking after her three daughters.

Thank you.

[The prepared statement of Ms. Craft follows:]

PREPARED STATEMENT OF ELAINE L. CRAFT

Introduction

Chairman Lipinski, Ranking Member Ehlers, and distinguished members of the Subcommittee, I appreciate having this opportunity to testify about broadening participation in STEM—science, technology, engineering and mathematics. My name is Elaine Craft, and I am an employee of Florence-Darlington Technical College located in Florence, South Carolina. I am a chemical engineer, and I have worked in industry and. for many years in STEM education in technical and community colleges, first as a teacher and administrator and more recently as Principal Investigator and Director of a National Science Foundation-funded Advanced Technological Education (ATE) Center dedicated to increasing the quantity, quality, and diversity of highly skilled engineering technicians to support our nation's economy.

The term "technician" is not always understood. The technicians that I will be referring to are the same ones that are the focus of the National Science Foundation Advanced Technological Education program, known as the A–T–E program. These technicians require rigorous college-level academic preparation in STEM that is far more than a high school education but generally less than a four-year degree. Technician education programs are often associate degree granting programs. Industry-recognized certifications may be included. It is not uncommon for a scientist to design an experiment, and then for one or more technicians to perform the laboratory work to conduct the experiment; similarly, an engineer's design is likely to be installed, tested, maintained, and repaired by an engineering technician. Most employers require more technicians than scientists or engineers. The most successful companies recognize that the quality of this component of their workforce gives them a competitive edge in the global economy. Early in my career, I worked in a research facility for the Monsanto Chemical Company. I had a team of six engineering technicians assigned to me who implemented my designs and kept my pilot plant and testing operations functional. I experienced first-hand the absolutely critical role of technicians in research, manufacturing, and all engineering endeavors.

Technicians are hands-on, STEM practitioners that shoulder the responsibility for making most of our science, technology, mathematics, and engineering applications work. The preparation of these highly skilled technicians is an important part of the academic mission of the nation's two-year technical and community colleges. The demand for technologically sophisticated technicians is growing steadily in response to "baby boomer" retirements and advances in science and technology. Even in the current difficult economic environment, graduates of up-to-date technician education programs at two-year technical and community colleges are in high demand, and the jobs pay well. Students completing these programs have the option of entering the workforce immediately, or they may transfer to senior institutions to complete baccalaureate or higher degrees in STEM disciplines.

Today you are addressing the topic of broadening participation in STEM. A powerful way to do this is to attract and retain diverse students in STEM-focused programs at the community college level. Technical and community colleges enroll more than 11.6 M students and provide accessible higher education in every congressional district, whether rural, suburban, or urban. Since community colleges also enroll a higher percentage of minority students than any other sector of higher education, maximizing student recruitment and the effectiveness of STEM-based programs in these institutions provides a great opportunity and a very fertile environment for broadening participation in STEM.

My remarks today will demonstrate how National Science Foundation grant funding to Florence-Darlington Technical College is already contributing to the goal of broadening participation in Sl'IM, but there is still more work to be done. First, let me tell you about the college.

Florence-Darlington Technical College (description and demographics)

Florence-Darlington Technical College is one of 16 two-year colleges making up the South Carolina Technical College System. The South Carolina Technical College System functions as the state's community college system, but it was founded with an economic development mission. Florence-Darlington Technical College is located near the intersection of Interstate Highways 95 and 20, half-way between Maine and Miami, in the northeastern quadrant of the state. This year, the college has an enrollment of more than 5,200 students in its academic programs and thousands more in non-credit continuing education courses. According to the American Association of Community Colleges, approximately two-thirds of the nation's community colleges are the size of Florence-Darlington Technical College or smaller.

Florence-Darlington Technical College offers the following non-medical, Associate Degree STEM programs of study:

- Associate of Science
- Associate Degree, Engineering Technology
    - Civil Engineering Technology
        - Civil Engineering Technology Concentration
        - Graphics Technology Concentration
    - Electronics Engineering Technology
    - Electro-mechanical Engineering Technology
- Associate Degree, Automotive Technology
- Associate Degree, Machine Tool Technology
- Associate Degree, Heating, Ventilation, and Air Conditioning; and,
- Associate Degree, Telecommunications Systems Management (computer science)

The college also offers an extensive selection of Allied Health programs, such as nursing and dental hygiene.

The Florence-Darlington Technical College service area population is approximately 45% minority, and the college student population is approximately 50% minority. In comparison, the college faculty population is 23% minority. Demographics of the students enrolled in *medical STEM programs* are predominantly female (92%) but racially diverse (32% minority). Enrollments in *non-medical STEM programs* demonstrate the progress that is being made at the college in addressing the challenge being addressed by this Congressional Subcommittee, with enrollment in these programs that is now 27% female and 40% minority.

Effective Institutional Policies, Programs, and Activities

Florence-Darlington Technical College has policies, programs, and activities designed to increase diversity and broaden participation in all aspects of the college. Dr. Charles W. Gould, president, has led by example and created a culture of inclusiveness at every level of college operations. In recent years, the college has increased its internal research capacity and now has the necessary data to identify and address specific challenges students face from the time they enter the college through graduation. For example, a recent study pointed out an alarming achievement gap between African American and other students in entry-level science courses. Additional research is being conducted to understand why these students are struggling and guide faculty and administrators in designing interventions to address the underlying causes for the difference in success rates. Already, it is clear that differences in prerequisite STEM skills and knowledge are a major factor. My recommendation is for this subcommittee to address this issue in strengthening the STEM educational pipeline.

Much of the progress made in broadening participation in S1 EM at Florence-Darlington Technical College has resulted from targeted STEM initiatives that have been made possible by the National Science Foundation A1E program. With NSF funding, research-based innovations have been implemented with excellent results. In mid-1990, state-wide data for South Carolina's technical colleges indicated that only 12% of students entering engineering technology programs graduated, and 85% of those who graduated were white males. Additional research showed that the drop-out rate for engineering technology students is highest in the first year of study, which is made up primarily of core STEM subjects such as mathematics and physics. To increase student success rates in engineering technology programs and to broaden participation, a new, first-year curriculum was developed to better address the way students learn and to incorporate workplace readiness skills such as problem-solving and teamwork. Florence-Darlington Technical College was one of seven colleges that implemented the new Engineering Technology first-year curriculum developed by the South Carolina ATE Center.

NSF ATE initiatives at Florence-Darlington Technical College have achieved the following results: enrollment in engineering technology programs has doubled and the time it takes a student to graduate with an associate degree in engineering technology has been reduced from 3.8 years to 2.2 years. Using 1998 statewide baseline data, graduation rates at Florence-Darlington have increased from 12% to more than 40% and African-American enrollment has increased from 15% to 39%. The gains were attributed to faculty preparation that improved teaching methodologies and use of the new curriculum that supported better teaching methods; introduced problem-based learning; integrated content across mathematics, physics, technology, and communications; and encouraged teamwork among students and instructors.

Because so many two-year technical and community college students must work while attending college, time-to-graduation is rarely the two years that the phrase "two-year college" implies. Research data show that the longer the educational pursuit extends beyond two years for associate degree programs, the higher the dropout rate. Reducing time-to-graduation was addressed as a critical retention strategy, and the challenge was addressed in two ways. First, the credit hours required for engineering technology associate degrees were reduced to align with recommendations of the Technology Accreditation Commission of the Accreditation Board for Engineering and Technology (TACIABET). Next, the challenge of converting part-time students to full-time students was addressed with the addition of an industry-sponsored paid internship program that included scholarship support for interns. For the first time, students were provided with the opportunity to replace a 40-hour/week, minimum-wage job with a 20-hour/week internship that paid twice as much and enhanced their classroom instruction. These program improvements were implemented as part of a National Science Foundation ATE project that shortened time-to-graduation for engineering technology students from 3.8 years (range 2.0–7.0) to 2.2 years (range 2.0–2.4) while simultaneously providing industry with job-ready, experienced candidates upon graduation.

Florence-Darlington Technical College serves an economically disadvantaged student population. Approximately 68% of the student body received financial aid in the form of Pell grants for the fall 2009 semester. A National Science Foundation Scholarships in STEM (S–STEM) grant award has made full-time enrollment possible for academically capable but financially challenged students. The S–STEM "Tech Stars" scholarships at Florence-Darlington Technical College have been awarded to 140 students enrolled in non-medical STEMdisciplines. To date, 95 (80%) of the scholarship recipients have graduated with 82 Tech Stars graduating on time and with grade point averages of 3.0 or higher. Twenty-eight scholarship recipients are currently enrolled.

The success that has been achieved by Florence-Darlington Technical College has been supported and made possible by grant funding from the National Science Foundation, but the story does not stop there. It is perhaps even more important to note that over the past five years, the SC ATE Center has spread these innovations to educators across the country. Community colleges in more than 25 states from California to Maine and Wyoming to Texas are using one or more of the strategies that were tested and proven successful at Florence-Darlington Technical College. For example, the SC ATE faculty development model was used last year in Connecticut, Massachusetts, and North Carolina and the internship model in Colorado. As a result of our partnership with the National Dropout Prevention Center at Clemson University, the SC ATE Center's curriculum model is now being tested as a dropout prevention strategy in Georgia and South Carolina high schools with very promising results. Interest is growing as more high schools seek effective solutions to the dropout problem. Peer mentoring has become an important part of the work of the South Carolina ATE Center, and strategies for broadening participation are among those more often shared.

Challenges in Broadening Participation in STEM

While we have found some effective ways to broaden participation and increase student success, impact has been primarily on those students who are qualified to enter rigorous STEM-based programs like engineering technology. Unfortunately, too many students enter community and technical colleges without the pre-requisite knowledge and skills to be successful. I believe that one of the greatest challenges to broadening participation in STEM resides in the part of the academic pipeline where underprepared students entering college are served. According to a recent study from *Jobs for the Future* (*http://www.jff.org/*), **nearly 60 percent of students enrolling in U.S. community colleges must take remedial classes to build their basic academic skills. For low-income students and students of color, the figure topped 90 percent at some colleges.**

We are losing far too many potential STEM students at the point when they are required to complete additional academic preparation prior to becoming eligible to enroll in their chosen curriculum. Students deemed underprepared to enter their chosen program may be returning after years of being out of school, possibly facing challenges with English as a second language, and/or may be among the many who have not traditionally done well in school and/or did not take the necessary courses in high school to successfully pursue STEM programs in college. These students are "at risk" when they enter our institutions, and many are often first-generation college students. They face both academic and non-academic barriers to success.

A recent project at Florence-Darlington Technical College funded by the South Carolina Education and Economic Development Act uncovered many of the non-academic barriers to student success. It was discovered that first-generation college students often do not understand what differences they will encounter when attending college. For example, they may not know that lunch is no longer provided. They may not know that textbooks are not distributed by the institution but rather must be purchased by the student. A $175 price tag on a college physics book is shocking to most of us, but it is even more shocking and out-of-reach to them. They have parents who do not understand their role in providing information for the Federal financial aid application. While facing and adapting to these and many other non-academic barriers, they face academic challenges as well.

Consider the typical steps required for the underprepared student:

Not college-ready (lacks required English, reading, or math placement test/ SAT/ACT score)	Not STEM-curriculum-ready (lacks necessary high school laboratory science credits or required mathematics placement test/SAT/ACT score)	STEM curriculum (Student begins 2-year degree program after completing all remedial and/or prerequisite courses)
Student must take remedial courses in English, reading, and/or mathematics for which no college credit is awarded. →matriculates to introductory or "bridge" course(s) after demonstrating necessary competencies or improving placement test scores →	Student enrolls in prerequisite or "bridge" courses in biology, chemistry, mathematics, etc. for which college credit is awarded, but the courses do not count towards graduation requirements and will not transfer to 4-year colleges or universities. →matriculates to entry-level "Freshman" curriculum courses after earning satisfactory grades (often a grade of C or higher) →	"Freshman" STEM courses that apply towards an Associate Degree and are often accepted for transfer credit at 4-year colleges or universities.

The way we provide pre-curricular preparation can actually create an academic barrier, especially for aspiring STEM students. Placement testing targets only mathematics, reading, and English. There is little consideration of critical science and technology pre-requisite knowledge required for most STEM majors. Typically, none of the English, reading, and mathematics content in remedial, developmental or transitional studies contains the language of science and engineering, and there is no obvious correlation between what they are being asked to learn and the interest they may have in S I EM. Often these pre-curriculum courses are taught in a way that is a vivid reminder of the school environment where they did not excel before. Because this pre-curricular coursework bridges between what has been learned by the student prior to college and the baseline competencies expected for entry-level STEM coursework in college, it is overlooked in funding legislation and, by extension, does not get included in funding opportunities that could stimulate improvement. As data reported by Jobs for the Future illustrate, in every case, students from underrepresented populations in STEM are dominant among those needing additional preparation to be successful. While we wish this additional preparation were not necessary, I encourage you to consider this a point in the educational process that is ripe for improvement, and where improvement could produce considerable impact and broaden participation in STEM. New work and innovative thinking is needed about how to invite and initiate the underprepared student into a STEM-focused world with interesting activities and effective ways for diverse learners to succeed. Reading and English instruction should include the language and knowledge of science. Community and technical colleges are skillful in nurturing diverse and underprepared students but do not have the resources to completely rebuild the way we offer instruction for these students. What is needed is legislation and funding that will stimulate the development of activities that are rich in technology applications directed towards learning STEM and introducing STEM programs and careers. Mathematics should be taught from application to theory using problem-solving and real-world applications that answer the question "why am I learning this?"

While the National Science Foundation ATE program effectively connects high school programs and teachers to community college technician education and includes related STEM faculty development, more attention and funding opportunities are needed to specifically and effectively close the often overlooked but gaping "hole" in the academic STEM pipeline where we lose far too many capable but underprepared students, especially those from populations underrepresented in STEM. The NSF ATE program has funded a number of successful bridge programs, but these programs have typically been discipline specific. The outcomes from successful bridge programs can be used to guide the work that will be necessary to generalize pre-curriculum preparation at community colleges for all STEM disciplines. One challenge to infusing STEM in pre-curriculum studies is that this work will require the involvement of faculty from all STEM disciplines where currently only mathematics faculty are involved. Thus, pre-curriculum study will need to be enriched and expanded both in terms of what is taught, how it is taught, and by whom. Rigorous evaluation will be needed to determine what works and what does not work so that successful strategies can be broadly disseminated and replicated.

In summary, the one-size-fits-all strategy currently used in remedial, developmental, or transitional studies in our country is simply not meeting the needs of underprepared students who wish to enter STEM or STEM-based programs. If broadening participation in STEM careers is a priority for our nation, then that priority should be demonstrated much sooner in the college experience of more students. Funding specifically to replace traditional pre-curricular English, reading, and mathematics with STEM-rich and relevant content delivered in part by STEM-knowledgeable faculty using the language and laboratory equipment of science, active learning, and inquiry-based teaching methods will broaden participation in STEM by improving student success from that point forward in the academic pipeline, especially for underrepresented minorities.

Although there is a substantial body of research demonstrating that better teaching methodologies produce better student outcomes, there are still far too many educators wed to traditional academic practice. My experience in working with faculty to change teaching is that it takes more time to accomplish the transformation than is provided through typical funded projects of three or four years. Funding opportunities that encourage continued use of better teaching methodologies for longer periods of time are needed to help develop stronger communities of practice that are more likely to be sustained. Like wearing a retainer once braces are removed from your teeth by the orthodontist, support for improved teaching methods needs to be provided for a longer period of time after the initial faculty development to prevent teachers from lapsing back into more comfortable, but less effective teaching practices. Faculty development should be an integral component of all initiatives to broaden participation in STEM.

Conclusion

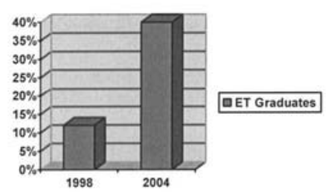
Chairman Lipinski, Ranking Member Ehlers, Members of the committee, thank you for the opportunity to share this information about the work being done at Florence-Darlington Technical College and the South Carolina Advanced Technological Education Center of Excellence. Funding from the ATE Program at the National Science Foundation has been transformative for our institution and for technician education in this country. Your support for this program is having a significant impact on broadening participation in STEM. Because of the NSF ATE Program, it has been possible for us to explore and discover successful ways to broaden participation in STEM and support our nation's economy in fields of emerging as well as traditional technologies.

ATE Success by the Numbers

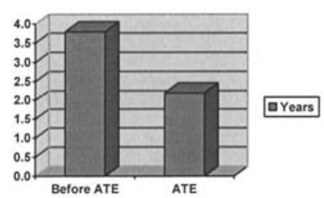
Florence-Darlington Technical College

- Results are in the numbers at Florence-Darlington Technical College, Florence, South Carolina, home of the South Carolina Advanced Technological Education (SC ATE) Center of Excellence.
- With funding support from the National Science Foundation, improvements have been made to address industry needs for a greater number of more highly skilled engineering technicians.
- Enrollment has doubled and the time it takes a student to graduate with an associate degree in engineering technology has been reduced from 3.8 years to 2.2 years. Using 1998 statewide baseline data, graduation rates at Florence-Darlington have increased from 12% to more than 40% and African-American enrollment has increased from 15% to 39%.

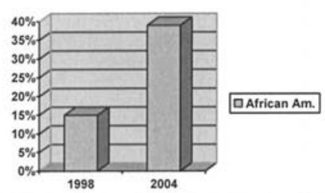
Graduation Rates



Time to Graduation



Diversity



BIOGRAPHY FOR ELAINE L. CRAFT

Elaine L. Craft has served as Director of the South Carolina Advanced Technological (SC ATE) Center of Excellence since 1994. The SC ATE Center is dedicated to increasing the quantity, quality and diversity of highly skilled technicians to support the American economy. Currently, she serves as Co-Principal Investigator for the SC ATE National Resource Center for Expanding Excellence in Technician Education. As SC ATE Director, she has served as principal investigator, project manager, and project developer/grant writer for multiple National Science Foundation grants for the South Carolina Technical College System and Florence-Darlington Technical College. The SC ATE Center is widely known for developing and broadly sharing successful educational models and practices in technician education, with a particular emphasis on the first year of study. An independent study conducted by Western Michigan University in 2003 ranked the SC ATE Engineering Technology Core, cross-disciplinary, project-based curriculum, 4.0 on a 0–4 scale for "its effectiveness in helping students learn the knowledge and skills and/or practices needed to be successful in the technical workplace."

In 2005, Elaine Craft founded SCATE, Inc., a 501(c)(3), not-for-profit corporation affiliated with Florence-Darlington Technical College, Florence, South Carolina. SCATE Inc. promotes systemic change in Advanced Technological Education and helps sustain and expand the work and impact of the SC ATE Center. Through

SCATE, Inc., successful practices in STEM and technician education, with a focus on rigorous evaluation, are being provided nationally to broaden participation and enhance advanced technological education and workforce development.

Ms. Craft received a baccalaureate degree in chemical engineering from the University of Mississippi and MBA from the University of South Carolina. In addition, she has completed additional graduate studies in mathematics. Early in her career, Ms. Craft worked as a chemical engineer for Union Carbide and the Monsanto Chemical Company. More recently, she has held both faculty and administrative positions within the South Carolina Technical College System. She served as vice chair of the SC Governor's Math and Science Advisory Board and has been honored with numerous awards including the South Carolina Governor's Award for Excellence in Science. Mrs. Craft received the Innovator in Education Award at the Eastern Regional Competency Based Education Conference in 2009 and was named Administrator of the Year for Florence-Darlington Technical College in 2007. Her other awards include the National Institute for Leadership and Institutional Effectiveness David Pierce Leadership Award, National Leadership Forum Achievement Award for Outstanding Partnership (Jobs for the Future), and Educator of the Year and Medallion of Excellence from Northeastern Technical College. Ms. Craft served on the National Science Foundation Advisory Committee for GPRA 2006–08 and has been an advisor to the National Science Board.

Chairman LIPINSKI. Thank you.

Before we begin our questioning, I want to apologize to our witnesses for my absence at the beginning. Right now, health care reform is trumping everything, and when you are called to a health care reform meeting, you go, so I apologize, but fortunately we did have Ms. Fudge, who is the Vice Chair of the Subcommittee, who has worked very hard on this issue. I thank Ms. Fudge for filling in at the beginning, and with that, I will recognize Ms. Fudge for five minutes for the first round of questions.

Ms. FUDGE. Thank you very much, Mr. Chairman, and thank all of you.

Before I get to my first question, I would like to say to Dr. Stassun that I think that the collaboration you have with Fisk is fabulous. If we are talking about engaging young people, especially minorities, to collaborate with a school that is full of minorities who already understand the rigors of what an education really is about I think is phenomenal, so I just want to congratulate you for your work, and I would love to see more people do the same kinds of things.

Dr. STASSUN. Thank you.

Ms. FUDGE. My first question is to Dr. Dowd. Dr. Dowd, you referenced a report that found many faculty and senior leadership don't buy into increasing access to and success in STEM education for minority and low-income students. Additionally, you cited research that emphasizes that African American students participate in mathematics education with an acute awareness of the dynamics of race and racism in their lives. In short, you have seen that racial stigma and discrimination are barriers to the participation of underrepresented racial ethnic groups in STEM courses. Among many other concerns, this information clearly demonstrates the need for more diverse STEM faculty.

I firmly believe in the power of role models. After all, you can't be what you don't see. So students don't see scientists that look like them. They have a hard time envisioning themselves as scientists. However, Dr. Malcom stated that despite the observed increase in the number of Ph.D.s awarded to minorities, there is not a corresponding increase in the number of minority faculty members. My question is, as we work to increase the number of racial and ethnic minorities receiving Ph.D.s, how can we simultaneously encourage them to teach, and what are the barriers to minorities becoming faculty members? Either of you, Dr. Dowd, and then Dr. Malcom, if you would like to respond as well.

Dr. DOWD. Well, thank you, Congresswoman. First I would like to offer a definition of racism in the sense that racism can be understood as social processes where we create hierarchies, and in the case of racism we use race as the categories by which to assign those social hierarchies. In consideration of entry to the faculty, we see in the numbers very low participation on the part of Latinos and African Americans, as you stated. Mentoring is extremely important, and mentors and role modeling—mentors can play very important roles as role models but in addition they can be active in understanding how to direct their students, doctoral students included, to resources that they need to gain entry to social networks and to doctoral study at prestigious institutions. So when we look, for example, at Hispanic students who enrolled in community colleges, the pathways to highly selective and prestigious doctoral programs at research universities are fairly narrow. Understanding how to navigate those pathways is difficult, and without the assistance of a role model and mentor to engage actively in problem solving and to direct students towards those resources, is very difficult. So I will turn it over to Dr. Malcom.

Dr. MALCOM. As Dr. Dowd said, there is a real issue with regard to the fact that institutions tend to recruit from peer institutions and therefore if you are not receiving your degree from one of the institutions that happen to be within the peer group, it is very difficult to break in. Now, there are ways to overcome that. For example, by taking a post-doc in a prestigious institution, it is possible to overcome some of that. But part of it relates to the fact—and I think that the ADVANCE program really found this out—is that there are really processes within institutions around hiring of faculty that don't necessarily work to expose the most diverse group of people to put into the pool to begin with. African Americans, for example, are more likely to say that they want to teach and go on to the faculty. The question is whether or not we actually have the pathways that can help them to move from the identification to the recruitment to the actual hire, and that is a complex process that involves, in many cases, the judgments of the existing faculty, as well as efforts that might be made in order to really reach out beyond the usual suspects to identify people who may be available and highly qualified to go into that applicant pool.

Ms. FUDGE. Thank you. And just a last question quickly if you could, I remember reading in someone's testimony that there is a belief that debt is a deterrent for minorities wishing to pursue graduate degrees in STEM, and I just want to know, is there a lack of financial support, and is it the most significant barrier to students' ability to pursue advanced degrees? Anyone?

Dr. DOWD. In collaboration with Dr. Lindsey Malcom of the University of California at Riverside at the Center for Urban Education, we studied the effects of debt on graduate school enrollment among bachelor's degree holders in STEM fields, and we see that debt is negative, particularly for Hispanic students, in pursuing graduate enrollment. So the use of scholarships and fellowships is probably one of the most important, or the funding of scholarships and fellowships is the most important thing that NSF can do in addition to what I focused on in my remarks, which is engaging in scholarship on active learning.

Ms. FUDGE. Thank you so much.

Mr. Chairman, I yield back.

Chairman LIPINSKI. Thank you, Ms. Fudge.

The Chair will now recognize Ms. Johnson, who has also done a wonderful job as always. She has been very interested in every piece of legislation and is looking out for this issue. Ms. Johnson.

Ms. JOHNSON. Thank you very much, Mr. Chairman.

My first question will be to all the members of the panel. In 2007, I offered an amendment which was incorporated in the original America COMPETES law, which, I quote, "directs the National Academies of Sciences to compile a report to be transmitted to the Congress no later than one year after the date of enactment of this Act about barriers to increasing the number of underrepresented minorities in science, technology, engineering and mathematic fields and to identify strategies for bringing more underrepresented minorities into the science, technology, engineering and mathematics workforce." We don't have this report yet, and yet we are now looking at the reauthorization of the *America COMPETES Act*. I would like to get from you specific policy directives that you would give to help eliminate these current barriers for minorities.

Dr. MALCOM. I will begin by a couple—I want to underscore Dr. Stassun's comments with regard to the need to have broader impacts criteria and actually applied more across the board. I do think that this has made a difference within the NSF. I was on the Science Board and actually a member of the criterion committee at that time, and I do think that it tends to reset the culture in the institutions. I do think that we have issues with regard to not only debt at the undergraduate level, but we have issues with regard to graduate school debt, and that debt tends to be highest among those groups that really can actually least afford it. But I would say that it isn't just about fellowships and traineeships. The kind of money one gets actually does matter. When money is actually associated with the training process, that is, that you have research assistantships and the like, it gets you entry into the lab, a key to the door and relationship with a mentor that is likely to be deeper and yet we basically are less likely to see African Americans reporting that they are getting, for example, research assistantships. In many cases, the faculty will choose to use those resources to support their international students because they do not carry the same requirements as the traineeships and fellowships do with regard to U.S. citizenship.

Now, I think that there are all kinds of issues around the notion of debt, and it is raising a real problem. I do think that there are also issues that relate to the lack of diversity among faculty. We are seeing research that says that it matters, at least for—recent research that came out last week about African American faculty and the effect of African American faculty on African American students' encouragement, support and retention into STEM. So I think that there is a whole panoply of things, some that cost new resources, some that don't. They just require different behavior and, really, the will to actually do things in a different way.

Ms. STASSUN. I will echo Dr. Malcom's echo of my recommendation to authorize other Federal funding agencies to adopt something like NSF's broader impacts language. I see myself as a front lines researcher, somebody who runs a lab and works one-on-one with students, and I, for personal reasons, bring a strong commitment to diversity in STEM, but what I see among my colleagues is that many of them who may not be able to initially relate to the broadening participation charge for personal reasons nonetheless are very entrepreneurial people and they see the broader impacts mandate from NSF. They want the prize of an NSF Career Award. They want to bring in the resources that are needed to build and sustain a world-class laboratory. And so they learn pretty quick how to effectively respond to broader impact and to broadening participation.

Dr. DOWD. In my written testimony, I elaborate on the notion of not only requiring performance benchmarking to show the impact of programs on producing additional students with degrees, but also diagnostic benchmarking in order to use best practices in ways that can be applied then to understand the organizational and structural changes needed within institutions, and in that respect we can also require what is called 'process benchmarking' whereby institutions look to peers and change their practices in order to achieve the performance benchmarks that are desired.

Dr. YARLOTT. For tribal colleges and for American Indians, I think for us, the lack of capacity to pursue these types of grants has been a detriment to us, but we also lack role models historically. But that is changing through this process, and the more American Indians that go into these STEM fields provides for opportunities seeing that, you know, others like us have gone on to be successful in those areas. So with us, originally it was because of the lack of resources to go after these types of grants and making people aware of them, but now those things are changing for us. Thank you.

Ms. JOHNSON. My time has expired, Mr. Chairman. Thank you.

Chairman LIPINSKI. Thank you.

The Chair will now recognize Dr. Ehlers.

Mr. EHLERS. Thank you, Mr. Chairman, and I apologize for dashing out but I had to give a talk to a group of students downstairs who are holding a session, and it is really heartening. One of them happened to be from my district, but it was kind of amusing because he has done some astrophysical work looking at galaxy clusters and so forth, and flying in on a plane yesterday, I read a paper from a former colleague at Berkeley who is doing the same and using it to verify Einstein's theory of general relativity and also the very likely existence of dark matter in the universe, and I find that really interesting that a high school student, I guess he was a beginning college student, could do research of that magnitude because the data is all there on the Internet and he was—you know, it is not exactly Nobel prize winning but it is very serious work and it is really heartening to see young people tackling those problems.

I appreciate the testimony I heard, and it is really striking, and I just—this is frustrating to me because I have trouble relating to some of the problems that people have. I had my own set of problems when I went off to college because I had been home schooled due to illness and I was completely maladjusted, which you still see occasionally. Otherwise I probably wouldn't be in Congress. But in any event, it is a tough go for minorities to come out from their situation where they are and getting into a totally different world—I observed that with students I have helped. At the same time, I think one of the problems is, and it is not just for minorities, it is for many, someone mentioned the problem, I think it was you, Shirley, something about males underrepresented in certain areas, and if you don't have the right role models and you don't have the right experiences as a child, sometimes it is very difficult, and we don't place enough emphasis on that. I would love to give a set of Tinker Toys and Lincoln Logs to every child born in the country, male or female, and have them have that experience of assembling things, making things, and especially making things run.

Dr. Dowd, you used a term that I wanted to have you amplify on. You talked about the need for a new pedagogy, and could you explain in a little more depth what you mean by that and how it applies to this issue?

Dr. DOWD. Yes. Thank you. When I use the expression "new pedagogy," I am thinking of the use of formative assessments within classroom settings and other learning environments whereby professors gain a sense of their students' development as learners and ask the question of themselves and other students each day, what have you learned here today, so that the emphasis is not on some evaluation with testing only but also on what students learn. To do this, professors need a set of skills that is not only content knowledge and pedagogical knowledge but also race knowledge. In this way, instruction can take account of the fact that learners are always in the process of developing new identities, new identities as college students, new identities affiliated with racial ethnic identification and new identifies as scientists, which is so important in terms of the passion for learning.

Mr. EHLERS. OK. That is helpful.

Something that was absent from the discussion when you were talking about minorities, no mention of Asian or Oriental students. Why not? What is different about them? Dr. Malcom?

Dr. MALCOM. They overparticipate in STEM compared to their total numbers within the college population. Now, that does not mean that there aren't issues with regard to Asian Americans who are participating in these fields. We are not, for example, necessarily finding them in leadership roles, even then we find them among the faculty and we find them getting the degrees, and they are not necessarily—Asian Americans are not necessarily a monolithic group. You have Hmong Filipino, for example, where those numbers and Pacific Islanders may look a lot more like underrepresented minorities while Korean, Japanese and Chinese may look different. So I think that this notion of disaggregation and unpacking the numbers, I think it applies in that particular case as well as in some of the other examples that we have seen.

Mr. EHLERS. Now, why is that? Why the difference? Are these cultural differences?

Dr. MALCOM. Some are cultural, some are socioeconomic, and I think that the real issue is that this is such a complex picture. It almost has to be looked at department by department, community by community in order to really understand how to actually meet individual students' needs, and that is, I think, the plea that Dr. Dowd is making, that we have got to get underneath a lot of this. But in cases where there is a strong sense of family push and support for certain fields, we see students oftentimes moving into those fields. At the same time, you will see that the Asian American student populations are not necessarily in the social and behavioral sciences fields at the same level that they might be in areas such as engineering or computer science.

Mr. EHLERS. When I was teaching at Berkeley, we had an arrangement with the Turkish university that we would exchange, or we would take some of their students, at least at the master's level and perhaps Ph.D., and work with them in the lab directly. I was really struck by how lack of certain things in the background makes it difficult, things that you might not think of, but for example, they had never worked on a car. Now, I don't regard working on a car being a mechanic as crucial to becoming a physicist, but they had no idea how to deal with equipment, how to handle it, and I just realized we really had to go back to step one and talk about what the equipment does, how you control it, how you use it and so forth. It never occurred to me before that that could be a major roadblock to a particular group of people, and I suspect you are having some of that in the minority issue here.

Dr. Dowd, you had another comment?

Dr. DOWD. I just wanted to speak to the question in regard to Asian students. Asian students also face racism and face limitation to their access of certain fields of study and certain professions. In the sciences, they are not necessarily underrepresented in the aggregate, but as Dr. Malcom pointed out, that is not true among different ethnic groups, so Asian students are also important in this discussion in understanding the differences and using the data available to us to look in a disaggregated sense is important, so better data that enables us to see the smaller units of analysis in terms of different ethnic groups is necessary. And I would just return to this notion of racism operating in the system of creating hierarchies within our society, and testing does that, so when we overemphasize Asians as a model minority, that is also, I would say, damaging towards the participation of Asian students in higher education as a whole.

Mr. EHLERS. Thank you. I yield back.

Chairman LIPINSKI. Thank you, Dr. Ehlers.

I will now recognize Mr. Tonko.

Mr. TONKO. Thank you, Mr. Chair.

Ms. Craft, you, in your testimony, attributed gains in STEM graduation rates to faculty development, including improved teaching methodologies and the use of new curricula. Can you elaborate for the panel how these changes were implemented?

Ms. CRAFT. Dr. Dowd described part of what we are doing, which includes a lot of the formative assessment strategies. Often we teach from application to theory rather than the traditional theory to application. This helps the student understand why they are learning something, and creates a 'need to know', and we find that if you create a need to know, then they become very inquisitive and they want to learn more and you can actually teach them how to learn, how to, you know—there is a lot of lip service given to self-directed learners and that sort of thing, but how do you make that happen? And this is one of the ways in which you do that, giving them real-world problems to solve, teaching them how to work in teams, teaching a problem-solving process so that—I mean, essentially we are having to prepare students today to work in technologies that haven't yet been invented, to solve problems that we don't we have yet.

Mr. TONKO. And you said that they are also implementing these across the country with many other institutions?

Ms. CRAFT. Yes, it started with a collaboration among the technical colleges in South Carolina and then, you know, piece by piece we have spread it across the country.

Mr. TONKO. And they are seeing, I would think, the same sort of improvements?

Ms. CRAFT. Where you can get the teachers to actually change their teaching methodologies, you do get these improvements, yes.

Mr. TONKO. And Dr. Dowd, in your testimony, you state that there are certain pathways to STEM bachelor's degrees that just aren't necessarily part of that process from the community college, that there should be, what I read into it, greater access into the matriculation route toward a bachelor's degree. Why is this? Is there anything that can be done to improve that access? It seems to me, if the community colleges are the campus of choice, shouldn't we have those bridges to STEM degrees that would advantage the student?

Dr. DOWD. Yes, improving transfer and improving articulation I think are a really important part of this equation for increasing the numbers of Hispanic students earning bachelor's as well as graduate degrees in STEM. I believe that faculty collaboration between two-year college faculty and university faculty in developing curricula and aligned programs and degrees is very important, and also providing encouragement to states to allow community colleges to offer degrees in STEM fields in community colleges is also important. While bachelor's degree numbers have improved for Hispanic students in STEM, associate's degree numbers are fairly flat, so we have, I would say, a supply problem in providing enough spaces within community colleges and STEM fields, and part of this is hiring a new generation of faculty who can engage students in this area.

Mr. TONKO. Well, I noted that we did a lot to move the President's push to provide more community college assistance might just respond to that dilemma in a way that allows us to offer the space and cultivate the two-year degrees than bridges to the four-year.

All of you as a panel, or most of you, if not all, made mention of some 60 to 90 percent of students enrolled in community college as requiring or participating in remedial programming. Is there something that should be done in the remedial layer in that exercise that encourages STEM connection? Is there something that we should be doing beyond what is being done now that would really advance that? Ms. Craft.

Ms. CRAFT. As I pointed out, what I have found is that the total—remedial studies are typically reading, English and math. There is no science, engineering or technology there. And those other three topics are never taught in the context of STEM and STEM careers, and I think that can make a huge difference for these students.

Mr. TONKO. Does anyone else on the panel have a comment? Yes, Dr. Dowd.

Dr. DOWD. Yes. The mathematics curriculum in remedial or developmental education is highly segmented into skill-based study so that, for example, in a California community college, a student would need to take three to four classes in mathematics before they earn any credits that will count towards transfer for a bachelor's degree. This can take years. So dismantling this process of a long segmented skill-base study into curricula that are connected to careers, occupations and actual problem-solving would be beneficial to shorten the length of time needed to earn degrees and to engage students.

Mr. TONKO. So where should the push come, then, to make those improvements, to make those reforms happen? Should it be left to the individual states or should there be some sort of incentive program from the feds? What would make that come around in a way that really feeds the STEM——

Dr. DOWD. I think that NSF's focus on transformative initiatives focused on pedagogy and curriculum reform will provide the incentives for colleges to work together to reshape their curriculum, and I do believe that that is important.

Mr. TONKO. Dr. Malcom?

Dr. MALCOM. Let me underscore that in a perfect world, there would be no need for remediation, but the world is——

Mr. TONKO. Good point.

Dr. MALCOM. —not perfect. I do think that we do have to continue to look at K–12 and what is actually happening at the high school level. I think that the points that have been made about the fact that the mathematics instruction needs to be grounded and connected to something that is real, so that students really get it about why you have to do this, as well as having pedagogical strategies that actually support their learning, but I think that we haven't really explored the limits of technology in terms of being able to develop things that really are online where students can support their own learning a lot more and have a way of beginning to kind of, first of all, figure out our where their deficiencies might be, and then being able to work together in order to address them. So I think that this is something that, once identified as a problem, there is an opportunity to really do some experimentation and some sharing in order to try to get over it.

Mr. TONKO. Mr. Chair, I know I am over my time, but if I could just close with one related question. Is there enough dialog between community colleges and the pre-K–12 setting, are they feeding back what they are seeing and then hopefully inspiring some sort of reforms in that pre-K? I think the elementary setting is one that really needs to advance science and tech and especially with, you know, so many of the students not really realizing that technical side of the elementary setting.

Dr. MALCOM. I am concerned that we really have not had the kind of mathematics instruction, period, that we need. It has been heavily focused on getting past the next test as opposed to being able to actually use it in real-world settings. I am hopeful that with the kind of standards conversations that are going on now that states that—that people who have responsibility from K through postgraduate will have conversations about what the expectations are, about what students will need to go from one level to the next. Some of the states are setting up these councils so that there is this kind of conversation that goes beyond, but I agree with you that it needs to start early. But it needs to be different, and that is the part where we really haven't been engaged to date.

Mr. TONKO. Thank you.

Dr. Dowd.

Dr. DOWD. NSF's funding can be used to encourage faculty at all levels, K–12, community colleges and universities, to come together and to think about how is math best taught, what is a mathematics pedagogy that is appropriate to new technologies including online mediated learning, and currently those boundaries are pretty hard in terms of little collaboration across sector and I think that incentives to collaborate are needed.

Mr. TONKO. Thank you. Was Dr. Stassun going to say something or——

Dr. STASSUN. I would be happy to add a remark but I want to respect your time.

Mr. TONKO. Go ahead.

Dr. STASSUN. I think, Congressman, that you put your finger on something terribly important with respect to this idea of understanding the pathways that students take as they move through the various stages and steps in the higher education system. When we created the Fisk-Vanderbilt Master's-to-Ph.D. Bridge Program, it was specifically data driven. It was incredibly enlightening for me to learn not only the very, very important role that historically black colleges and universities and other minority-serving institutions continue to play in educating our talented minority students in STEM, but specifically to learn that if you look at the different pathways that minorities in STEM and their non-minority counterparts take en route to a Ph.D. in STEM, they are very different. A non-minority student will traditionally take the path where you earn a baccalaureate degree at Institution A and then a master's degree or perhaps forego the master's degree altogether and a Ph.D. at Institution B, one transition. Underrepresented minorities in STEM, on the other hand, are 50 percent more likely to take a path that is baccalaureate degree at Institution A, a terminal master's degree at Institution B and then a Ph.D. at Institution C. And so in creating our program we did it specifically to tap into that pathway that the students are already taking and have been blazing on their own for decades. We have, in essence, tapped into that, surrounded it with deliberate mentorship and preparation, but most importantly, engaged the students in a spirit of handoff so that we don't just say, you know, here is piece A, here is piece B, here is piece C, we hope that you traverse those steps successfully.

Rather, we do a deliberate mentoring handoff from one stage to the next, and I think that idea of understanding the pathways and of preparing deliberate handoffs from one step to the next through collaboration between institutions is very, very important.

Mr. TONKO. Thank you.

Thank you, Mr. Chair. It just reminds me of the some of the campuses that I have been familiar with where when they have built or extended those campuses, they wouldn't lay the sidewalks down that were all planned. They would allow the paths to be developed and they would put the sidewalk there. I think we should be doing the same thing here with curriculum.

Chairman LIPINSKI. Thank you, Mr. Tonko.

Mr. Inglis.

Mr. INGLIS. Thank you, Mr. Chairman.

You know, I wonder what it is that causes people like me to be intimidated by science so by the time I had gotten to maybe 8th or 9th grade, I decided that it wasn't for me. But I think that in part maybe it is hard to teach. I don't know. I wonder if it is hard to teach science. When I got to law school, what I found is, law is very easy to teach because it is all about stories and cases that are really stories about human endeavor and you can get into the stories. But the challenge, it seems to me, with science, at least the way it was taught to me, was that it seemed somewhat rote to start with and it didn't seem to connect up. In law, you know, Your Honor, it will connect up. If you are asking a series of questions that don't really seem to make sense, you say to the judge, Your Honor, it will connect up, and sometimes he or she will let you keep going. So in the case of science, I wonder if the challenge is getting it to connect up early enough that people start seeing the connections and get excited about it. The people that I know that have gotten excited about science, like my kids, for example—I have got five kids—they are very excited about science, but somehow along the way they saw the connection sooner than I did.

Am I just idiosyncratic here in my experience or is that the case? Do we have to have some inspiration early on to make the connections, perhaps hands on? What is it that makes it so that people get these connections and get fired up?

Dr. STASSUN. If I may, my personal experience is that I was told as a young boy and all the way through elementary school, middle school, high school and even going into college, I heard from teachers constantly, Keivan, you are going to be a great scientist or mathematician, you are very good at science. I heard that phrase over and over again all my life. And it wasn't until I was an advanced undergraduate in college and got involved in a real astronomical research project with a mentor that I realized I had been told my whole life I was excellent in science and up until that point I had never done science. I had learned about science. I had learned the facts and the algorithms of science and I was quirky enough and idiosyncratic enough to be satisfied with that. But I think you are putting your finger on a very, very important point, and that is, whether it is hands-on or discovery-based learning or other methods, some way of giving students who have the talent and the ability very, very early on to experience what science is all about, which is actually not about knowing the answers but about asking the right questions and having some skill and idea about how to pursue answering those questions.

Mr. INGLIS. Yes, sir.

Dr. YARLOTT. By no means I am really an expert in science, but my experience is that with our students, with American Indians, we don't have those positive role models to begin with. Then those that are teaching in our K–12 programs don't have a strong background in those areas, so I think they feel uncomfortable in teaching the STEM areas, most specifically, math.

A number of years ago through a NSF–TCUP program called the Rural Systemic Initiative Program, we were able to work with the K–12 programs and just when we got to the point where we thought we got everything squared away, where we were doing our jobs really well, that program went away, so we are faced with that same problem again, and through those processes at our tribal colleges, for instance, in our situation, we went from three to four science majors to over 50 now and it is through those types of developments that we were able to reach down into the K–12 programs and then advancing that to our community colleges.

Mr. INGLIS. Is the future going to be that we have these super-inspirational teachers that appear to students on the Web individually so that, in other words, a student then can access the best teacher in the world who is so excited about making the connections in geometry such that that student can get online with that professor or watch a lecture? Is that the future, or is the future trying to get the proficiency of these classroom teachers who sometimes don't get the connections themselves? It's like David McCullough says, we should only let historians teach history because if you have got somebody that got a degree in education and they are trying to teach history and they are not excited about history, they are going to bore all the students. So if you have somebody at M.I.T. who is really great at teaching science, and I think M.I.T. is doing this online, right? You can go and get the best professors ever telling you about something of their area of expertise. You get excited about it, right? So which is the future? Ms. Craft, do you think it is trying to get the proficiencies up in Florence and Greenville and Spartanburg or do you think it is connecting Florence and Greenville and Spartanburg to M.I.T.?

Ms. CRAFT. I think it is going to be a combination simply because of student learning styles, and I think that the interdisciplinary approach, and several of my colleagues have mentioned that in their talks as well. For instance, if you do a science project, it is never just a science project. You can't do a science project if you are not also doing math. You can't do a project if you are not doing communications. So it is a matter of connecting, as you said, connecting the dots, and when we teach in silos and our faculty don't have opportunities to see what is going on in the related subjects and how they fit together, I think we have got a big faculty development challenge as well.

Mr. INGLIS. You know, when I was in law school, UCC, Uniform Commercial Code, is pretty dry but Bob Scott was the dean of the University of Virginia Law School and he loves the UCC. He is absolutely passionate about the UCC. And it made him the most incredible professor for teaching what probably most lawyers in the room would think was the most horrible course they ever had in law school. Bob Scott made it fascinating because every lecture, he would come in there excited, "You can't believe what we are going to learn today about this connection between article 2 and article 3." So that is what I hope for our students is people like Bob Scott teaching them things that—you know, UCC is pretty exciting if you get it, but I am not saying that I still remember all of it, I tell you, it has been a while ago.

But anyway, Dr. Malcom, you look like you want to add something to that.

Dr. MALCOM. Yes. I just wanted to say that every person who comes into the world is a scientist. They discover the world that is around them. They discover their own versions of the physical laws. They discover their own version of, is that thing alive or is it not alive. They are an open door. I think that we basically kill off a large part of that curiosity and enthusiasm with uninspired teaching. No one really wants to go into a classroom and be a terrible teacher. So the question then becomes, well, how do we help people to become inspiring teachers? One of the first things is that the way that teachers are actually educated is a real issue, and that is, are they taught their own science and mathematics in ways that are exciting and engaging. This is a complex system. We are not going to address the issues that relate to teachers until we address the issues that relate to the people who taught them and the ways in which they become inspired and excited and that they gain a command of the subject area.

We have a program here in the District of Columbia where we work with veteran teachers, and in this particular case, this is a partnership with George Washington University in a master's of practice program, and while we give them the pedagogy and information about learning, the learning sciences, what we now know about how people learn and engage, we go back and we make sure we give them content and give it to them in a way that they can give to someone else, that they get excited and enthusiastic about it and they are able to pass it on and also engage their students.

I hope that we don't look to any one spot to try to find the answer because this is a systems problem, and we have to think about how we engage every part of it in order to really give kids the opportunity to retain their birthright as scientists.

Mr. INGLIS. That is very interesting.

Thank you, Mr. Chairman. I am way over time. Thank you.

Mr. EHLERS. Will the gentleman yield?

Mr. INGLIS. I would be happy to.

Mr. EHLERS. Thank you.

I appreciate your comments, Dr. Malcom, and when I began teaching, I asked myself what could I do as one person to deal with some of the problems that we are talking about, and I started a special course for future elementary school teachers teaching them physical science, which was a required course, but I also expanded that to talk about how to teach science, which created some problems for the department of education, which was very concerned about me getting into their turf. But one thing I did which turned out to be very fascinating, I told the students at the beginning, the very first class, what I was up to and said, in my experience, virtually every teacher I knew taught as they had been taught, and I said I want you to try to break that chain, so they each to have to have a little notebook, they had to carry it with them all the time, and every Friday they had to turn in examples that they had seen in classes that they were taking of a good teacher doing something exceptionally good or a bad teacher doing something exceptionally bad or anything in between, and they had to analyze it and write just 100 words at most, and then I would once a month share those with the students and we would talk about it. It was really fascinating, and the students initially of course begrudged it but then they really began to enjoy it. I insisted they were not allowed to write down the names of the professors involved and we were just going to talk about pedagogy. It is something I would recommend for anyone teaching future teachers because it makes them, for the first time in their lives, think about how they are being taught and analyzing whether it is good, bad or indifferent. But it gave me a lot of insight too into what the students really need and want, because that came out of there too. So it was a fascinating exercise and, you know, if I had the time and didn't get diverted into politics, I would have enjoyed doing summer institutes on that with teachers and just try to analyze it.

Yes, Dr. Dowd.

Dr. DOWD. Your comments give me greater appreciation of your question before in regard to new pedagogies, because apparently you did the new pedagogy when you started with your interest in this area. But the process you described, of data collection and careful data analysis about instructional practices, is in fact at the heart of my recommendations in regard to what—I call the process 'benchmarking' but which is also known as inquiry. Inquiry is a reflective process, about, how is what I am doing contributing to the success of my students, and so that type of data collection is really necessary to reframe this problem from problems with students to problems of practice. And at the Center for Urban Education, with funding from the NSF, we are currently in a dissemination phase of our grant and we are designing what we call our STEM toolkit, and the toolkit includes protocols and materials that instructors can use to engage in this type of data collection and reflection about their own practices as teachers.

Mr. EHLERS. I should have met you 40 years ago. But I did have one firm rule. I announced at the first class of the year that every day I was going to tell a joke, and my jokes were terrible and so they weren't going to enjoy them and the only way they could stop me is to come with their own jokes, and it just set a totally different frame in the classroom right from day one. The joke became the joke, in other words, and we had a lot of fun with that.

Yield back.

Chairman LIPINSKI. Thank you, Dr. Ehlers. I almost hate to keep going on or change the subject because I think this one certainly is really critically important. It gets down to the heart of what we are talking here, but I will start by recognizing myself for five minutes. I just wanted to add on, I am not going to make any comments about Mr. Inglis and not being interested in science. He just slipped out of the room.

I always—it is like Dr. Malcom said, I have always thought of it as we all come into the world as scientists. I thought maybe it was just me. I wound up going on and getting a couple degrees in engineering, Ph.D. in political science, but I always think that naturally we look—try to figure out the world, and it is a scientific process. In science, talking about pedagogy and analyzing how we are teaching, if we are teachers, as I was doing before I was elected here, I think the science of analyzing how am I teaching, what am I doing. But it is very difficult and it takes time and effort to be able to do that, but it certainly is critical.

I remember going back earlier in my life, I didn't—when I was in grade school, I don't think it was a particularly advanced school that I was in by any means, but when I was in 7th or 8th grade, they asked if any students wanted to go and teach sort of science to 2nd and 3rd grade, something like that, and so I did that, and I still remember some of the things that I did at that time trying to teach the younger kids about rain and where rain comes from and what that does in terms of growing and trees and things like that, and another one on magnetism, which I remember didn't work out very well. I still remember that. But again, it is a good way. We have to keep working on better teaching at all levels.

Now, this is going to be—it is sort of more fun talking more generally, sort of at the lower levels, but I want to ask a question, you know, relating to what Dr. Malcom had suggested in her testimony, that major research universities need to be more accountable and take responsibility for students' success or lack of success in STEM. So I am interested in sort of two things, one general, one more particular to what we are addressing today. First, how can the Federal Government incentivize this type of self-assessment and improvement? And second, since a lot of money goes to these institutions in support of NSF broader impacts requirement, how can broader impacts proposals be better applied and leveraged to yield better results in broadening participation? We want to make sure as we are reauthorizing the NSF and America COMPETES that we are spending the money in the best way possible and providing the incentives that are necessary at our major research universities. So how can this be done better? I will start with Dr. Malcom.

Dr. MALCOM. I think that Dr. Stassun probably said it best, that faculty are very entrepreneurial and that they will basically figure it out if they are required to do something about it, and the broader impacts criteria actually holds a real opening for being able to do more and to do better. But I think that there has to be an accounting with regard to those issues as well. Let me explain what I mean. If I submit a proposal to the National Science Foundation, one of the things that they are going to ask me is, how did I do on the last money I gave you. So I have to report on the accomplishments from the previous funding. Now, I report on the technical side, but I don't necessarily have to report on the broader impacts side. And I think just that particular piece, having to actually report on both aspects, the technical as well as the broader impacts, and beginning to do some kind of an audit or reflection on the part of committees of visitors and other kinds of processes within the Foundation could have a real major impact. But rather than just to have it seem like it is a carrot issue, why not begin to actually reward, with recognition, those places that come up with exemplary broader impacts? We recognize teachers, outstanding teachers. We recognize outstanding researchers. We recognize young investigators. We recognize all kinds of things. Why not begin to recognize when someone has done a particularly solid piece of work with regard to these issues and that they can actually make a case and present the evidence that in fact that they have done this?

Chairman LIPINSKI. Thank you.

Dr. Dowd.

Dr. DOWD. I would second that the evaluation process for NSF grantees can create incentives for the organizational learning and faculty learning that is needed to make a difference, and so moving beyond just measuring effectiveness of particular programs and asking, in what ways has an institution learned as a result of the incubator of best practices that is going on at a program level, is part of the expectation that should be set. So evaluations should move towards broader impacts at the institutional level, not just at the level of programs, and we can, for example, develop surveys of faculty beliefs about their own effectiveness or efficacy in increasing diversity in STEM fields. That is just an example. For example, at the Center for Urban Education, we are developing indicators of faculty effectiveness in engaging around issues of diversity. And so we can use these types of surveys, not just to ask about students, are you engaged or are you motivated, are you expending effort, but then to ask that question on the faculty side of the equation and on the institutional side as well.

Chairman LIPINSKI. Dr. Stassun?

Dr. STASSUN. Mr. Chairman, I would emphasize again that unfortunately, currently NSF is on its own as a Federal funding agency with explicitly requiring this kind of language in the evaluation of funding proposals that are submitted to it. I am referring specifically to the broader impacts language. It would help tremendously, I think, if that kind of priority and explicitness were present in the other Federal funding carrots that are available to entrepreneurial researchers.

The second thing that I would add, however, is that perhaps ironically, it is often the case through NSF funding programs, specifically those that are focused on broadening participation, that one of the reasons there is not currently a higher level of accountability for progress that was made, lessons that were learned in previous grants that were awarded is because very often a grantee, a recipient of an NSF funding award focused on broadening participation, will very often be excluded from going back for a second round of funding in order to have the opportunity to demonstrate, here is what we accomplished with the first round, here is what we learned, here is the metrics, here is the data, here is how we can show that we are performing and that we deserve to at least be considered for another round of funding.

On the research side, on the technical side, what we do as researchers is—and we are very incentivized and motivated to do this—is we keep careful track of the products of our research, of what comes out of the previous round of funding because we know in three, four or five years we are going to have to write another proposal to NSF and say we are ready for the next stage of our program and here are the specific concrete products of the last investment that you made in us. Not having the opportunity to do that in multiple rounds or multiple stages of innovation and development on the broadening participation side I think is currently a limitation for tapping into the entrepreneurial spirit of these researchers.

Chairman LIPINSKI. Dr. Yarlott?

Dr. YARLOTT. I don't disagree with any of the other panel speakers. I agree with the evaluation in a broader sense. When we start talking about evaluations at tribal colleges, they tend to take a look at numbers, and at tribal colleges, when we are dealing with small numbers of students and how it impacts just the numbers themselves, then the question would be, are we being successful. But on the other side, what it impacts is that it is just not the students or the faculty members that are being impacted but the families and the communities, how the word of mouth and how it goes out and how it impacts a whole community, how we are able to change policies within school systems and so forth. So the broader impacts is what is really key to us at tribal colleges, because we do lack the resources to continue to move forward as far as competing for these kinds of grants, when you have faculty and staff that carry on multiple tasks within the system, because we are understaffed to begin with. For example, some of our faculty members, aside from teaching 15 to 16 credit loads, they are also managing other Federal grants, so it is those kinds of things that it really does impact in a broader sense for us at tribal colleges. Thank you.

Chairman LIPINSKI. Thank you.

With that, I think we are going to complete the testimony for today. I want to thank our witnesses for all their testimony and answers to the questions here. The record will remain open for two weeks for additional statements from Members and for answers to any follow-up questions the Committee may ask of the witnesses.

Thank you again. The witnesses are excused and the hearing is now adjourned.

[Whereupon, at 11:53 a.m., the Subcommittee was adjourned.]

Appendix:

ANSWERS TO POST-HEARING QUESTIONS

ANSWERS TO POST-HEARING QUESTIONS

Responses by Alicia C. Dowd, Associate Professor of Higher Education, University of Southern California, and C-Director of the Center for Urban Education

Questions submitted by Vice Chair Marcia L. Fudge

Q1. I liked your idea of convening a panel of experts in culturally responsive pedagogy alongside scientists and social scientists to develop the language for a program solicitation. Could you please elaborate on your vision for this Program Solicitation? How else can the Federal Government assist in encouraging faculty to introduce culturally responsive pedagogies in classrooms?

A1. In regard to your first question, I envision that NSF would convene a Culturally Responsive Teaching in STEM Review Panel, which would be a standing panel of seven educational experts appointed to a three-year term. Panel members would be charged with providing ongoing guidance to NSF about how to incorporate culturally responsive teaching and pedagogy into STEM through NSF supported research and programs.

NSF's director should appoint the panel based on nominations from presidents of the major academic professional associations.[1] Selected nominees should be those whose scholarship demonstrates a significant contribution to the development and application of culturally responsive pedagogy in and outside of STEM fields. (I include other fields because the bulk of this work has been conducted outside of STEM fields.)

Based on the work of Dr. Gloria Ladson Billings of the University of Wisconsin Madison, Dr. Geneva Gay of the University of Washington, and others, culturally responsive pedagogy (also known as culturally responsive or culturally relevant teaching) has the following characteristics:

1. A focus on student learning and achievement, based on
   a. Teacher recognition of students' ability to learn;
   b. Teacher recognition of students' prior knowledge and cultural assets;
   c. A curriculum that invites students to question and assume an active role in shaping social structures, including those that create forms of institutional racism and perpetuate racial bias through educational practices;
2. Teachers and students have cultural competence, which means
   a. Students don't experience a conflict between their racial or ethnic identity and succeeding in school or college;
   b. Teachers can apply knowledge of their students' cultural backgrounds in their teaching and curriculum development.
   c. Historical and contemporary forms of racism and racial bias are acknowledged in the curriculum.
3. Sociopolitical awareness, because
   a. For both teachers and students, education is understood to be for the public good and includes the aim of creating a better society.

To judge the quality of the scholarship of panel nominees and their suitability for service on the Culturally Responsive Teaching in STEM Review Panel, NSF's director should ask noted scholars such as Dr. Ladson Billings, Dr. Gay, Dr. Estela Mara Bensimon (University of Southern California), Dr. Brian Brayboy (University of Utah), Dr. Kris Gutiérrez (UCLA), Dr. Sylvia Hurtado (UCLA), and Dr. Danny Martin (University of Illinois Chicago) to form a selection advisory committee. Subsequently, committee members will nominate their successors for appointment by NSF's director and they may institute staggered terms of appointment.

The first charge of the Culturally Responsive Teaching in STEM Review Panel should be to review and recommend revisions to the language of current Program Solicitations in NSF's Broadening Participation portfolio (including in the categories

[1] In education and the social sciences, these associations include the American Educational Research Association, American Sociological Association, American Psychological Association, and American Anthropological Association. In STEM disciplines it includes the American Association for the Advancement of Science, American Mathematical Society, the American Mathematical Association for Two-Year Colleges, American Physical Society, American Society for Engineering Education, and numerous field-specific associations in biology, chemistry, geology, engineering, technology, and other sciences.

of Broadening Participation Focused and Broadening Participation Emphasis). The revised Program Solicitation language should communicate to Principal Investigators the standards for review of proposals, such that priority will be given to funding STEM educational programs and research that incorporate or develop culturally responsive educational practices.

The second charge to the Culturally Responsive Teaching in STEM Review Panel should be to articulate research and evaluation standards for improving our knowledge of the educational practices that are culturally inclusive and that reduce racial bias in STEM classrooms.

NSF's *Broadening Participation at the National Science Foundation: A Framework for Action* (August, 2008) planning document lists several strategic action items that can also be guided by the Culturally Responsive Pedagogy in STEM panel. These include:

- Provide training to NSF program officers;
- Diversify the pool of Program Solicitation reviewers;
- Orient proposal reviewers to NSF's broadening participation goals;
- Provide learning opportunities for Principal Investigators;
- Provide guidance concerning promising practices and models;
- Evaluate broader impacts.

The Culturally Responsive Teaching in STEM Review Panel should advise on the development of training and orientation materials and strategies. The members should also articulate research priorities.

In regard to your second question, I first note that the application of culturally responsive pedagogy has been fairly limited in STEM college classrooms and learning environments. STEM faculty who undertake this work will be innovators. They will require support through peer networks to communicate what they learn for broader change in the culture of STEM classrooms. In this context, the Federal Government can best assist in encouraging faculty to introduce culturally responsive teaching in their classrooms by creating a prestigious fellowship that would provide funding for sabbatical leaves for well regarded STEM faculty to immerse themselves in the development of a STEM-focused culturally responsive pedagogy.

Criteria for awarding sabbatical funding should include:

- The quality of the design of a sabbatical project to expand the applicant's knowledge of culturally responsive teaching;
- The applicants' demonstrated capacity to collect and analyze data on his or her own teaching relative to the characteristics of culturally responsive teaching;
- Willingness to engage in reflective practice about what is required of STEM faculty to engage in culturally responsive teaching (e.g. the challenges and rewards);
- A dissemination plan for communicating what is learned with peers (e.g. through conference presentations, workshops, and journal articles);
- A plan for broader impacts on institutional and disciplinary practices;
- Responsiveness on feedback from reviewers in revising resubmitted applications.

Ideally, the sabbatical funding will enable a year of immersion in the study of culturally responsive pedagogy, the development of innovative STEM curricula, and experimentation with new teaching practices. Implementation of the dissemination plan may occur towards the end of the sabbatical leave or in the following years. Applications from small groups of STEM faculty from institutions of different types (e.g. community colleges and research universities) who jointly design and implement coordinated projects should be given priority.

To promote alliances across different types of institutions, awards should be distributed among faculty from two-year colleges, liberal arts colleges, research universities, Historically Black Colleges and Universities, Hispanic Serving Institutions, and Tribal Colleges. Fellowship recipients should be asked to convene together once in the fall and once in the spring during their sabbatical leaves to share ideas. Previous fellowship recipients should be asked to serve as peer mentors and to review applications in subsequent years.

If instituted, the Culturally Responsive Teaching in STEM Review Panel should be asked to play a role in determining the elements of the sabbatical fellowship Program Solicitation, eligibility and review criteria, and objectives by which to evaluate the effectiveness of this approach to faculty development and STEM curricular change. The program evaluation should include an assessment of the participants' subsequent leadership roles in their disciplines and at their institutions in transforming STEM curricula; teaching and self assessment practices; student recruitment, selection and assessment criteria; and faculty professional development.

I appreciate this opportunity to expand on my recommendations and will be happy to clarify these ideas as needed.

ANSWERS TO POST-HEARING QUESTIONS

Responses by Elaine L. Craft, Director of the South Carolina Advanced Technological Education National Resource Center, Florence Darlington Technical College

Questions submitted by Vice Chair Marcia L. Fudge

Q1. The industry-sponsored paid internship program you described in your testimony sounds like a great way to not only address the financial difficulties that students face, but also to give them real-world technical experience. Could you provide some detail on how this program was established, and how can Members of Congress help to incentivize partnerships such these?

A1. Industry-sponsored, paid student internships are integral to an organized employer collaboration with Florence-Darlington Technical College. The Advanced Technological Education Industry Consortium was founded almost eleven years ago to address the shared challenge among local employers of a shortage of highly skilled engineering technicians that are required for their businesses to be globally competitive. At the time of the organizational meeting, the college was not producing enough engineering technology graduates to meet employer needs. As a result, employers often found themselves in a no-win cycle of hiring talent away from other local employers. A major local industry hosted the meeting that started the initiative. Meeting participants agreed that the goal should be to increase the overall pool of qualified technicians to support local employment needs, and that an internship program augmented by scholarship support would be implemented in collaboration with the college. The internship program was designed to effectively employers to "grow their own" talent and future workforce. Employers agree to hire student interns at the same starting salary and not to employ the students full-time until they graduate. As part of the agreement, financial need (tuition, fees, books/supplies) for a participating students that remains unmet after other Federal financial aid and college scholarships have been awarded is paid by the employer who hires the intern.

Tax credits for providing paid internships would stimulate broader business/industry participation, especially among smaller businesses.

Q2. In your testimony, you mentioned that between 60 and 90 percent of students enrolled in community colleges must take remedial classes before they can earn credits toward their STEM degrees. However, it was also noted during the hearing, that many of the first year STEM degree courses are designed as "weed out" courses, creating an initial barrier for students to overcome in the pursuit of a STEM degree. How can we improve these gateway courses and overall learning experiences so that students are encouraged, rather than discouraged, to pursue degrees and careers in STEM?

A2. Students who are underprepared to be successful in STEM courses are currently placed in developmental reading, English, and/or mathematics courses that have no science, technology, or engineering content and thus have no relevance to STEM careers and provide no encouragement or information that would stimulate a student to pursue a STEM career. Mathematics is the only part of STEM that is taught at the developmental level, and it is taught out of context and is seen as a barrier to a student's advancement rather than as a critical basic skill that is used in science, technology, and engineering. Developmental education has changed very little over the years and is rarely, if ever, a funding priority for colleges although the numbers of students requiring this service continues to grow.

Grant-funded projects supported by the National Science Foundation have demonstrated that when underprepared students are provided with hands-on, relevant learning opportunities, these students can master important STEM content/skills and be encouraged to pursue STEM careers in biotechnology, engineering technology, nursing/health sciences and other STEM careers that are in high-demand. The most significant action Members of Congress can take to improve the current system is to provide financial incentives to enable and encourage educators to reform developmental studies specifically to increase the number of diverse students who pursue STEM careers. Grant funding to two-year technical and community colleges should specifically encourage these educational organizations to improve the developmental, pre-curriculum learning experiences for all students by adding science, technology, and engineering courses and/or imbedding STEM content, applications, and hands-on inquiry-based learning within developmental studies. Financial support for the recruitment and preparation of sufficient numbers of STEM faculty to make this transformation possible will be critical to success and should also receive targeted funding support.

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