Elaine Leggett Craft, MBA

Director

South Carolina Advanced Technological Education (SC ATE) Center of Excellence, a National Resource Center for Expanding Excellence in Technician Education

U.S. House of Representatives

Testimony

Before the House Committee on Science and Technology

Subcommittee on Research and Science Education

March 16, 2010

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 4-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 STEM, but there is still more work to be done. First, let me tell you about the college.

<u>Florence-Darlington Technical College (description and demographics)</u>

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 STEM at Florence-Darlington Technical College has resulted from targeted STEM initiatives that have been made possible by the National Science Foundation ATE 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 (TAC/ABET). 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 STEM

disciplines. 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 STEM. 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 re-build 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

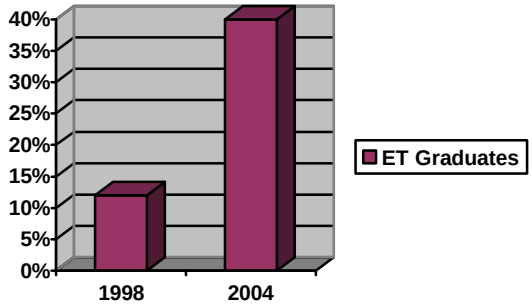
Chairman Lipinski, Ranking Member Ehlers, Members of the committee, thank you for the opportunity to share this information about the work being done at Florence-Darlington Technical College and the South Carolina Advanced Technological Education Center of Excellence. Funding from the ATE Program at 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

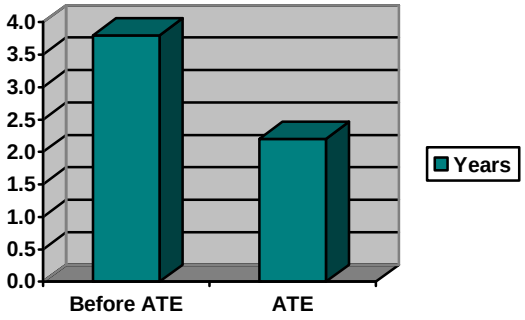
Florence-Darlington Technical College

- 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