ENCOURAGING THE PARTICIPATION OF FEMALE STUDENTS IN STEM FIELDS

HEARING

BEFORE THE

SUBCOMMITTEE ON RESEARCH AND SCIENCE EDUCATION

COMMITTEE ON SCIENCE AND TECHNOLOGY

HOUSE OF REPRESENTATIVES

ONE HUNDRED ELEVENTH CONGRESS

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July 21, 2009

ENCOURAGING THE PARTICIPATION OF FEMALE STUDENTS IN STEM FIELDS

TUESDAY, JULY 24, 2009

HOUSE OF REPRESENTATIVES,
SUBCOMMITTEE ON RESEARCH AND SCIENCE EDUCATION,
COMMITTEE ON SCIENCE AND TECHNOLOGY,
Washington, DC.

The Subcommittee met, pursuant to call, at 10:12 a.m., in Room 2318 of the Rayburn House Office Building, Hon. Daniel Lipinski [Chairman of the Subcommittee] presiding.

BART GORDON, TENNESSEE
CHAIRMAN

RALPH M. HALL, TEXAS
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COMMITTEE ON SCIENCE AND TECHNOLOGY
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Hearing on

Hearing on Encouraging the Participation of Female Students in STEM Fields

Tuesday, July 21, 2009
10:00 a.m. – 12:00 p.m.
2318 Rayburn House Office Building

Witness List

Dr. Alan I. Leshner
Chief Executive Officer, American Association for the Advancement of Science (AAAS)

Dr. Marcia Brumit Kropf
Chief Operating Officer, Girls Incorporated

Dr. Sandra Hanson
Professor of Sociology, Catholic University

Ms. Barbara Bogue
Associate Professor of Engineering Science and Mechanics and Women in Engineering, Penn State College of Engineering

Ms. Cherryl Thomas
President, Ardmore Associates LLC

HEARING CHARTER

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

Encouraging the Participation of Female Students in STEM Fields

TUESDAY, JULY 21, 2009
10:00 A.M.–12:00 P.M.
2318 RAYBURN HOUSE OFFICE BUILDING

1. Purpose

On July 21, 2009 the Subcommittee on Research and Science Education of the House Committee on Science and Technology will hold a hearing to examine current research findings, best practices, and the role of the federal agencies in increasing the interest of girls in science, technology, engineering, and mathematics (STEM) in primary and secondary school, and addressing the challenges that deter young women from pursuing post-secondary STEM degrees.

2. Witnesses

- **Dr. Alan I. Leshner,** Chief Executive Officer, American Association for the Advancement of Science (AAAS).
- **Dr. Marcia Brumit Kropf,** Chief Operating Officer, Girls Incorporated.
- **Dr. Sandra Hanson,** Professor of Sociology, Catholic University.
- **Ms. Barbara Bogue,** Associate Professor of Engineering Science and Mechanics and Women in Engineering, Penn State College of Engineering.
- **Ms. Cherryl Thomas,** President, Ardmore Associates LLC.

3. Overarching Questions

- What is the current status of the participation of girls in STEM in primary, secondary, and post-secondary school? How does participation vary by field? How does it vary by other demographic categories, including race, ethnicity, and socioeconomic status?
- What are the biggest challenges to increasing girls' interest and participation in STEM learning at the K–12 level, and to recruiting and retaining female undergraduates in STEM fields? Are there policies, programs or activities with demonstrated effectiveness in increasing the interest and participation of girls and young women in STEM? What roles can scientific organizations, formal and informal educators, non-profits, and businesses play in addressing these challenges and providing opportunities for girls to become engaged in STEM? What role can the Federal Government play in addressing these challenges? Are there particular federal programs or resources that can be most helpful?
- What assessment tools exist for evaluating the effectiveness of such programs? What are the barriers to improving assessment?
- What is the current state of research on the involvement of girls in STEM? What do we know about how teaching strategies, cultural norms, educational environments, and other outside factors shape girls' interest and participation in STEM? What are the biggest unanswered research questions?

4. Brief Overview

- A highly-skilled, STEM educated workforce is essential to ensuring U.S. competitiveness and leadership in the global economy of the 21st century. However, according to many reports, our country is facing a shortage of workers

skilled in STEM. By broadening the STEM pipeline to include those who have been historically under-represented in STEM fields, we create a larger, more diverse STEM talent pool.

- In recent years, increased attention has been paid to the issue of gender inequity in STEM. Numerous reports have highlighted the continued lack of participation of girls and young women in certain STEM fields, most notably in the fields of engineering, physics, and computer science.
- Research findings suggest that women and other under-represented groups face unique challenges at multiple stages of the STEM pipeline, beginning at an early age.
- Both federal programs as well as non-governmental organizations and programs have been created to address these challenges.

5. Current Status of Participation of Female Students in STEM Fields

Enrollment

According to data compiled by the National Science Foundation (NSF), in 2006 women earned more than half of all Bachelor's degrees (58 percent). Women also hold more than half of all science and engineering degrees (51 percent), but with notable variation among fields. Women earned more than half of the Bachelor's degrees in psychology (77 percent), biological sciences (62 percent), and social sciences (54 percent), and almost half (45 percent) in math. However, in certain STEM fields, women remain largely under-represented. Women received only 20 percent of computer science degrees, 21 percent of physics degrees, and 20 percent of engineering degrees. Due to continued attrition throughout graduate school as well as other factors that deter women from entering STEM careers, women make up almost half (49 percent) of the Nation's workforce, but only 25 percent of the STEM workforce.

Achievement

The most recent National Association of Educational Progress (NAEP) assessment reports a small but persistent gap in performance between boys and girls in grades 4, 8, and 12—less than one percent for math and less than three percent for science. Many researchers suggest that issues such as self-confidence and perceived expectations negatively affect the achievement of girls on standardized tests.

6. Barriers to Increased Participation

A report of the Commission on the Advancement of Women and Minorities in Science, Engineering, and Technology suggests that there are four key time periods in which women seem to lose interest in STEM: at the beginning of middle school, towards the end of high school, throughout college and graduate school, and in their professional lives.[1]

Research suggests that in elementary school, as many girls as boys have positive attitudes about science. A recent NSF funded study of fourth graders showed that 66 percent of girls and 68 percent of boys reported liking science. By the eighth grade, however, boys report twice as much interest in STEM careers as girls. Issues such as stereotypes, cultural expectations, self-efficacy and the behavior of teachers and parents are all potential contributors to girls' attitudes about STEM at an early age. Barriers persist as young women leave high school to enter post-secondary school. Although women now make up the majority of undergraduate students, participation of women in STEM degree programs remains markedly low. Issues such as a lack of female role models or a female peer group, and unsupportive classroom environments have been shown to deter women from pursuing or remaining in STEM degree programs in post-secondary school.[2]

The National Science Foundation (NSF), a major funding source for research on gender and STEM learning, compiled the following list, based on NSF research findings, of five common myths about girls and science:[3]

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[1] Congressional Commission on the Advancement of Women and Minorities in Science, Engineering, and Technology Development. (2000). *Land of Plenty: Diversity as America's Competitive Edge in Science, Engineering and Technology.*

[2] Fancsali, Cheri. *What We Know About Girls, STEM and Afterschool Programs.*

[3] *http://www.nsf.gov/news/news_summ.jsp?cntn_id=109939*

1. Myth: From the time they start school, most girls are less interested in science than boys are.

Reality: In elementary school about as many girls as boys have positive attitudes toward science. A recent study of fourth graders showed that 66 percent of girls and 68 percent of boys reported liking science. But something else starts happening in elementary school. By second grade, when students (both boys and girls) are asked to draw a scientist, most portray a white male in a lab coat. The drawings generally show an isolated person with a beaker or test tube. Any woman scientist they draw looks severe and not very happy. The persistence of the stereotypes start to turn girls off, and by eighth grade, boys are twice as interested in STEM careers as girls are. The female attrition continues throughout high school, college, and even the work force. Women with STEM higher education degrees are twice as likely to leave a scientific or engineering job as men with comparable STEM degrees.

2. Myth: Classroom interventions that work to increase girls' interest in STEM run the risk of turning off the boys.

Reality: Actually, educators have found that interventions that work to increase girls' interest in STEM also increase such interest among the boys in the classroom. When girls are shown images of women scientists and given a greater sense of possibility about the person they could become, the boys get the message too—"I can do this!"

3. Myth: Science and math teachers are no longer biased toward their male students.

Reality: In fact, biases are persistent, and teachers often interact more with boys than with girls in science and math. A teacher will often help a boy do an experiment by explaining how to do it, while when a girl asks for assistance the teacher will often simply do the experiment, leaving the girl to watch rather than do. Research shows that when teachers are deliberate about taking steps to involve the female students, everyone winds up benefiting.

4. Myth: When girls just aren't interested in science, parents can't do much to motivate them.

Reality: Parents' support (as well as that of teachers) has been shown to be crucial to a girl's interest in science, technology, engineering and math. Making girls aware of the range of science and engineering careers available and their relevance to society works to attract more women (as well as men) to STEM careers. Parents and teachers are also in a position to tell young people what they need to do (in terms of course work and grades) to put themselves on a path to a STEM career.

5. Myth: At the college level, changing the STEM curriculum runs the risk of watering down important "sink or swim" course work.

Reality: The mentality of needing to "weed out" weaker students in college majors—especially in the more quantitative disciplines—disproportionately weeds out women. This is not necessarily because women are failing. Rather, women often perceive "Bs" as inadequate grades and drop out, while men with "Cs" will persist with the class. "Bridge programs" that prepare students for challenging course work can counteract this. One of the most effective interventions to help young women choose and sustain a STEM educational path and subsequent STEM career is mentoring. In addition, changing the curriculum often leads to better recruitment and retention of both women and men in STEM classrooms and majors. For example, having students work in pairs on programming in entry-level computer science and engineering (CSE) courses leads to greater retention of both men and women in CSE majors.

Title IX of the Education Amendments of 1972, the federal law that outlaws sex discrimination at schools receiving federal funds, has had a notable impact on womens' participation in athletics. In recent years, some advocates have called for applying Title IX to science and engineering departments, as a means to address barriers to women in these fields. However, there is no consensus on how Title IX might be applied to academic departments across diverse fields and institutions.

7. Federal Support for Gender Equity in STEM Education

NSF Research on Gender and Science in Engineering Program

The National Science Foundation is the largest public funding source for research on the participation of girls and women in STEM. Beginning in 1993 with the establishment of the Program for Women and Girls, housed in the NSF's Division of Human Resource Development in the Directorate for Education and Human Re-

sources, NSF began investing in research projects to improve the representation of girls and women in STEM. The Research on Gender in Science and Engineering Program (GSE), which grew out of the 1993 program, funds research designed to add to the body of knowledge on gender and STEM. GSE supports research on gender-related differences in learning, student and educator programs, as well as dissemination projects that aim to inform education practicioners about relevant research findings on how educational experiences, teaching styles, curriculum, institutional culture, and other factors affect female student interest, participation and performance in certain STEM fields.

In 2003 and 2006, the GSE program at NSF produced a series of publications with information and resources designed to help educators, employers, and parents promote gender diversity in STEM. *New Formulas for America's Workforce: Girls in Science and Engineering* is a two volume series presenting research and best practices on how to attract girls and women to the STEM disciplines. It also presents the results of various intervention programs that have succeeded in overcoming obstacles and enhancing the participation and achievement of girls in STEM. The agency then followed up with the *New Tools for America's Workforce*, a supplementary publication that catalogs the various resources available to educators through NSF.

The FY09 budget for the Research on Gender and Science in Engineering Program was approximately $11.5 million. Three of the witnesses on the panel today have received, or are currently receiving NSF funding through the GSE program.

Support at Other Agencies

There are a variety of education programs and activities across the federal agencies that seek to encourage the participation of girls in STEM. NASA, often in partnership with a number of girl-serving organizations, such as the Girl Scouts, provides opportunities for young girls to learn about NASA and interact with female astronauts. For example, the NASA Summer Institute in Science, Technology, Engineering, and Research (SISTER), is a five-day summer program for middle-school girls. In the SISTER program, 6–8th grade girls are given the opportunity to interact with NASA research scientists and explore STEM career fields. The Department of Energy supports programs for girls and young women as well. One such program, the Conference on Undergraduate Women in Physics, is designed to provide workshops, panel discussions, and other opportunities for female undergraduate physics students to interact with other women in the discipline.

The Department of Education has also been active in promoting gender equity in STEM. In 2007, the Department of Education, through the Institute for Education Sciences, released a Practice Guide entitled, *"Encouraging Girls in Math and Science."* The guide was developed by a panel of experts with the goal to compile the best available evidence-based recommendations to assist educators in encouraging girls in the fields of math and science. The guide offers a series of five recommendations for educators:

(1) teach students that academic abilities are expandable and improvable;
(2) provide prescriptive, informal feedback;
(3) expose girls to female role models who have succeeded in math and science;
(4) create a classroom environment that sparks initial curiosity and fosters long-term interest in math and science; and
(5) provide spatial skills training.

8. Questions for Witnesses

Dr. Alan I. Leshner

- What is the current status of the involvement of girls in STEM? What are the biggest challenges to attracting and retaining young women and girls in STEM fields, and what are the most promising solutions to these challenges?
- What role can scientific organizations such as AAAS play in helping to address these challenges? Please describe AAAS work targeted at increasing girls' interest and participation in STEM learning.
- What role can the Federal Government play in increasing the interest of girls in STEM at the primary and secondary education level, and in addressing the challenges that deter young women from pursuing post-secondary STEM degrees?

Dr. Marcia Brumit Kropf

- What is the current status of the involvement of girls in STEM? What are the biggest challenges to attracting and retaining young women and girls in STEM fields, and what are the most promising solutions to these challenges?
- What role can organizations such as Girls Inc. play in addressing these challenges and providing opportunities for girls to become engaged in STEM? Please describe the work of Girls Inc. and the evolution of your STEM programming. What programs or activities at Girls Inc. have been effective in increasing girls' interest and participation in STEM learning, and what were the key elements that led to their success? Are there common characteristics of programs that have demonstrated success in attracting girls to STEM?
- What role can the Federal Government play in increasing the interest of girls in STEM at the primary and secondary education level, and in addressing the challenges that deter young women from pursuing post-secondary STEM degrees? What is the nature of your interaction with federal agencies? Are there particular federal programs or resources that can be most helpful?

Dr. Sandra Hanson

- Please provide an overview of your research. What have you learned about what shapes girls' interest and participation in STEM?
- What is the current status of research on the involvement of girls in STEM? What do we know about how teaching strategies, educational environments, and other outside factors affect girls' interest or achievement in STEM in the elementary, middle, and high school years? What are the most important unanswered research questions?
- How can dissemination of these research findings be improved so that formal and informal educators and education policy-makers implement best practices?

Ms. Barbara Bogue

- Please provide an overview of the Society of Women's Engineers' Assessing Women in Engineering Project. What metrics and methodologies exist for assessing and evaluating the effectiveness of programs designed to increase girls' participation in STEM? What are the barriers to improving assessment and developing better metrics? What kinds of programs or policies have been shown to be effective through rigorous evaluation?
- In your role as associate professor of Women in Engineering at Penn State, what do you see as the biggest barriers to recruiting and retaining female undergraduates in STEM fields? What programs or activities at your institution (or others you are familiar with) have been effective in addressing the barriers you identified above, and what were the key elements that led to their success?

Ms. Cherryl Thomas

- What influenced your decision to pursue a career in engineering, and what were some of the greatest barriers you faced as a woman in a STEM field?
- What are the biggest challenges to attracting and retaining young women and girls in STEM fields, and what are the most promising solutions to these challenges?

Chairman LIPINSKI. The hearing will now come to order.

Good morning, and welcome to the Research and Science Education Subcommittee hearing on *Encouraging the Participation of Female Students in STEM Fields.*

For the past decades, girls and women have made substantial gains in breaking down barriers in both education and the workforce. However, women's participation rates in certain STEM disciplines remain disproportionately low. According to NSF (National Science Foundation), although women earned more than half of all science and engineering Bachelor's degrees in 2006, they earned only about 20 percent of degrees in engineering, computer science, and physics. Although this is an improvement from the time when I was earning my mechanical engineering degree at Northwestern 20 years ago, more can be done to encourage women in these fields.

We have heard time and time again that as a nation, we are not producing enough scientists and engineers for the increasing number of technical jobs of the future. We need to make sure that we have the scientific and technical workforce that we need if we are to remain a leader in a global economy, and it is not possible to do this without developing and encouraging all the talent in our nation. We must have women engineers, computer scientists, and physicists. By broadening the STEM pipeline to include more women and other unrepresented groups, we can strengthen our workforce.

In the last Congress, Chairman Baird worked with Ms. Johnson to focus on issues for women in academic science and engineering. Today, we look at the beginning of the pipeline, and examine what factors impact women in STEM fields, from kindergarten through the end of college.

The issue of female students in STEM fields is something that is really close to home for me. My wife is an actuary, and a fellow with the Society of Actuaries, has gone through all of her exams, and reached the top of her field. And I asked her what encouraged her, what really impacted her along the way, and for her, it was an advisor in college who recommended that she go and talk to a math professor who really encouraged her to be a math major, and encouraged her to thereafter go into actuarial sciences. So, that was her story, and that is how she wound up where she is today.

We know that women can face unique challenges throughout the STEM pipeline, and we invited today's witnesses to help us understand what these barriers are, and how we can break them down. It is important for the Federal Government to do its part in supporting research and programs that encourage best practices to attract and retain women in STEM, but there is a role for disciplinary societies, formal and informal educators, nonprofits, businesses, and other stakeholders.

Fortunately, there is a lot of good work already underway to address some of these challenges, and I look forward to hearing from our witnesses today about what is working, what obstacles remain, and where we go from here. I thank all of our witnesses for being here today, and I look forward to your testimony.

Now, the Chair will recognize Dr. Ehlers for an opening statement.

[The prepared statement of Chairman Lipinski follows:]

PREPARED STATEMENT OF CHAIRMAN DANIEL LIPINSKI

Good morning and welcome to this Research and Science Education Subcommittee hearing on *Encouraging the Participation of Female Students in STEM Fields.*

Over the past few decades, girls and women have made substantial gains in breaking down barriers in both education and the workforce. However women's participation rates in certain STEM disciplines remains disproportionately low. According to the NSF, although women earned more than half of all science and engineering Bachelor's degrees in 2006, they earned only about 20 percent of degrees in engineering, computer science, and physics. Although this is an improvement from the time I was earning my mechanical engineering degree from Northwestern University 20 years ago, more can be done to encourage women in these fields.

We have heard time and time again that, as a nation, we are not producing enough scientists and engineers for the increasing number of technical jobs of the future. We need to make sure that we have the scientific and technical workforce we need if we are to remain a leader in the global economy, and it is not possible do this without developing and encouraging all the talent in our nation. We must have women engineers, computer scientists, and physicists. By broadening the STEM pipeline to include more women and other under-represented groups, we can strengthen our workforce.

In the last Congress, Chairman Baird worked with Ms. Johnson to focus on issues for women in academic science and engineering. Today we look back to the beginning of the pipeline, and examine what factors impact women in STEM fields from kindergarten through the end of college.

The issue of female students in STEM fields hits close to home for me. My wife is a fully credentialed actuary. I asked her what led her down this path. For her it was her college advisor and a math professor.

We know that women can face unique challenges throughout the STEM pipeline, and we invited today's witnesses to help us understand what those barriers are and how we can break them down. It is important for the Federal Government to do its part in supporting research and programs that encourage best practices to attract and retain women in STEM, but there is a role for disciplinary societies, formal and informal educators, non-profits, businesses, and other stakeholders. Fortunately, there is a lot of good work already underway to address some of these challenges, and I look forward to hearing from our witnesses today about what is working, what obstacles remain, and where we go from here.

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

Mr. EHLERS. Thank you, Mr. Chairman, and thank you for the good words you have just spoken.

Today's hearing is an opportunity for us to gain insight into the reasons why young women are being deterred from pursuing careers in science, technology, engineering, and mathematics, better known as STEM. And I think it is essential, because each one of us tends to think we know what the problem is and what the answers are, but I think when we listen to the experts here today, we will find out how wrong we are, looking at it from our male perspective.

Strengthening math and science education is essential to the future of American economic competitiveness, and the lack of female participation in these areas is a great hindrance that must be remedied, for one reason, just out of fairness to all involved. Secondly, because the Nation can certainly benefit from the involvement of more individuals interested in math and science.

Despite the fact that women represent more than half of all Bachelor's degrees, they constitute only 25 percent of the STEM workforce in the United States. I spend a considerable amount of time and effort in Congress promoting STEM education, and this committee has held multiple hearings on the topic, paying particular attention to the need for more women and minorities in STEM fields. As a professor, I have also spent a good deal of time trying to interest women in math and science, particularly with the

idea of developing new opportunities for them, but also, since many of them were to become teachers, also changing their perspective on math and science, and why it is important to teach math and science to everyone in elementary school.

While great strides have been made since my days as a student, and later as a professor of physics at Calvin College and at Berkeley, the data still show great disparities in the participation of women in STEM. Much to my dismay, women represent only 21 percent of physics degrees, according to the National Science Foundation. It is my hope that today's observations will offer this committee insight into ways to better support these important fields of study as we continue to explore any federal role.

I look forward to the testimony of our distinguished panel. I thank them for being here, but I just have to add one point that I think is essential, and that is the jobs of the future are going to require of the workers a basic understanding of the fundamental principles of mathematics and science. I don't think there is any disagreement with that. If we do not, in some way, persuade women to learn these topics in the elementary and secondary levels, we and they are automatically cutting themselves out of a great many job opportunities in the future.

So, let us hope we can do a better job than we have done. I look forward to hearing from each and every one of you. Thank you.

Chairman LIPINSKI. Thank you, Dr. Ehlers. As usual, with your background as a physicist and also, the great concern that you have for science in this country and scientists, you always have a lot of important things to add, and it is good to have you working with me on this.

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

So now I would like to introduce our witnesses. First, we have Dr. Alan Leshner, who is the Chief Executive Officer of the American Association for the Advancement of Science.

Next, we have Dr. Marcia Brumit Kropf, who is the Chief Operating Officer of Girls Incorporated. Dr. Kropf comes to us from New York, and Mr. Tonko had hoped that he would be here to introduce her himself, but unfortunately he is tied up with another committee this morning and will try to join us at some point.

Next, we have Dr. Sandra Hanson, who is a professor of sociology at Catholic University. We have Ms. Barbara Bogue, who is an Associate Professor of Engineering Science and Mechanics and Women in Engineering at Penn State.

And finally, we have Ms. Cherryl Thomas who I know from back home in Chicago, who has worked not only in the administration of Mayor Daley, but also in the Clinton Administration. Ms. Thomas is currently the President and Founder of Ardmore Associates, an engineering construction management firm in Chicago.

As our witnesses should know, spoken testimony is limited to five minutes each, after which the Members of the Committee will have five minutes each to ask questions, so I ask you hopefully to stay in the five minutes here. Your complete written statement will be added to the record.

So, with that, we will start with Dr. Leshner. I recognize you for five minutes.

STATEMENT OF DR. ALAN I. LESHNER, CHIEF EXECUTIVE OFFICER, AMERICAN ASSOCIATION FOR THE ADVANCEMENT OF SCIENCE

Dr. LESHNER. Thank you, Mr. Chairman, Dr. Ehlers, thank you for your leadership in convening this hearing, and thank you for the invitation for us to testify.

As you know, the American Association for the Advancement of Science (AAAS) is the world's largest multi-disciplinary scientific society, and we are the publishers of the well-known journal *Science*.

Our involvement in education extends from pre-kindergarten through postgraduate, and into the careers of the scientific workforce. We have a long history of efforts to increase the participation of girls and young women, and to enhance the status of women in science, technology, engineering, and mathematics.

The first woman President of AAAS was elected in 1970, and since that time, 35 percent of those in the presidential line have been distinguished women. In 1973, AAAS created both an office of and a committee on opportunities in science, and their activities continue today.

I am very pleased to note that since the early days of advocacy and action related to women in STEM fields, the levels of enrollment and degrees awarded have overall increased dramatically. At K–12 levels, participation gaps between males and females have disappeared in such courses as chemistry, advanced algebra, and pre-calculus mathematics. This, then, has affected women's course taking and professional aspirations at undergraduate and higher levels. As one example, in 1977, women received roughly 22 percent of doctoral degrees in the biological sciences, but as you know, by 2006, women received almost half of biological science Ph.D.s in this country.

Despite this kind of progress, however, some serious challenges remain. And I have to start with the general statement that for K–12 education overall, science and math standards are unfortunately way too low for all students, whatever their career goals, whatever their genders, and we, as a country, have got to do something to change that. From my perspective, that is the largest problem facing education in this country.

In high schools and colleges, gaps still do persist for young women in pursuing courses like physics, calculus, and computer science, as you noted, but here, the percentage has actually decreased over time, and that needs focused attention.

Women overall have about a 40 percent share within the overall physical sciences, but that number masks the fact that in 2006, although women received half the Bachelor's degrees in fields like astronomy and chemistry, as you noted, women received only 20 percent of the Bachelor's degrees in physics, and women still receive only 20 percent of Bachelor's degrees in engineering. The gap is real; the gap exists.

It is more problematic that even when women do pursue science degrees, many leave the scientific workforce because of the lack of

career opportunities that enable them to do a better job balancing having a career and a life outside the laboratory. Fortunately there have been some, but frankly, too few federal programs, as well as changes in culture in some institutions to change this. Just as one example, the ADVANCE Program of the National Science Foundation is an example of an effective mechanism to foster these accommodations.

So, what can we do? Well, organizations like AAAS have a robust set of career-related activities generally, working cooperatively through something we established called a Center on Careers in Science and Technology. And both alone and through external partnerships, we produce materials that feature young and established women in STEM careers telling their stories, providing guidance to guidance counselors and educators.

We also have a Center on Advancing Science and Engineering capacity. Its purpose is to emphasize research-based interventions of demonstrated effectiveness, in order to help universities fully develop and utilize the talents of women and minority students and faculty. And I might point out that we try to provide role models as well. Women are active and visible participants in every aspect of the leadership of AAAS. Speakers and organizers of our meetings and conferences, leaders in the organization's governance, and I should point out that among the senior staff, over 50 percent are female.

How about the Federal Government? Many of us believe that a new call to serve for young men and women needs to link the critical role of education in STEM fields with the opportunity to address global concerns. Young people are far more interested in the relevance of what they do with their lives than they were, at least, in my generation, when I was trained as a scientist, where if you worried about relevance, you had sold out.

We also need much better data and statistics. It is critical to improve the recruitment and retention in STEM fields, to help identify measures of success, and to figure out what is working and what the climate is. We also need to support research to help us identify and better understand best practices that do work, that are effective in providing greater support.

Let me conclude by saying that it is critical that the United States have access to the full talent of all its citizens, and that every effort has to be made to enable that. As we face pressing societal challenges, all of whose solutions involve science and technology, either directly or indirectly, we can't afford to allow the great potential contributions of women to go untapped.

Thank you very much.

[The prepared statement of Dr. Leshner follows:]

PREPARED STATEMENT OF ALAN I. LESHNER

Chairman Lipinski, Ranking Member Ehlers, Members of the Subcommittee, thank you for the opportunity to testify today on the critically important topic of encouraging women and girls to pursue science, mathematics and engineering fields of study.

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.

AAAS has a long history of efforts to increase the participation of girls and young women and to enhance the status of women in science, technology, engineering and mathematics (STEM). The association has communicated this commitment to equal opportunity in many ways: 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 first woman President of AAAS was elected in 1970: Dr. Mina Rees, a mathematician. Since that time 35 percent of those in the presidential line have been women—all distinguished scientists, engineers, mathematicians and physician scientists. In 1971 the AAAS Council passed a resolution urging the establishment of a women's office. The goals of that resolution were realized in 1973 with the creation of the AAAS Office of and Committee on Opportunities in Science. The mandate of the office and committee was ultimately enlarged beyond the concerns of gender equity to include attention to issues of minorities and persons with disabilities.

Since those early days of advocacy and action related to women in STEM, the makeup of the larger science and engineering communities has changed. Fueled by societal changes regarding the participation of women in a range of career opportunities and improved access to science and engineering education for women, the levels of enrollment and degrees awarded increased dramatically.

At K–12 levels, young women greatly increased their course-taking in science and mathematics to the extent that participation gaps between males and females disappeared in courses such as chemistry, advanced algebra and pre-calculus mathematics. Women moved from nine percent of those earning M.D. degrees in 1972–73 to earning nearly 50 percent of M.D. degrees in 2007. We saw similar success in women's participation in the life sciences. Between 1973 and 1977, women received 22 percent of doctoral degrees in the biological sciences; by 2006 women received almost half of such Ph.D.s awarded.

Despite the progress achieved in the past there are many challenges that remain.

- In K–12 education, standards are unfortunately too low for **all** students and expectations lag, especially for students from groups without a clear history of participation in STEM fields.
- In high schools gaps persist for young women in pursuing study in courses such as physics, calculus and computer science. That gap continues to the undergraduate levels.
- In 2006, women represented only 20 percent of those receiving Bachelor's degrees in engineering.
- The percentage of Bachelor's degrees awarded to women in computer sciences was highest in 1984 at over 37 percent but has subsequently declined to today's level of 20.5 precent.
- There is a wide variation around women's participation within the broader fields of science and engineering. For example, women's 40+ percent share within the physical sciences masks the fact that women received half of the Bachelor's degrees in fields such as astronomy and chemistry but only 20 percent of Bachelor's degrees in physics in 2006. In addition, women received 19.4 percent of all engineering Bachelor's degrees in 2005–2006; this ranges from their 43.1 percent and 41.1 percent share of degrees in environmental and biomedical engineering degrees, respectively, to their 10.5 percent share of degrees in computer engineering on the other end of the spectrum.
- There is concern about the trajectory of doctoral production for women in many fields. For doctorates awarded to U.S. citizens and permanent residents there has been a plateauing or downward trending in women's share of degrees in mathematics, geosciences and computer science since about 2000.
- Even in fields such as psychology, where women have received more than 50 percent of Ph.D.s since the mid 1980's (and where they have received over two-thirds of doctorates since 1996), in 2007–2008 they were less likely to be in the rank of full professor (26.4 percent of women vs. 46.3 percent of men) and more likely to be in non-tenure track or lecturer positions. In chemistry, despite receiving at least 30 percent of Ph.D.s since the mid-1990's, women are not appearing in significant numbers among the ranks of the chemistry faculty in many of our major research institutions.
- Even where women may have reached the level of full professor at major research universities, climate studies of the academic environment at many of

these institutions reveal that women continue to face ongoing micro-inequities and lack diversity in the faculty hiring pools. And the hiring challenges are especially severe for women from under-represented racial/ethnic minority groups.

Although the story of women in STEM fields is one of tremendous gains over the past 40 years, it is a bittersweet story that is coupled with uneven progress and sometimes loss of ground—a discipline-specific program here, a department there, but seldom an institution-wide effort.

And even where women are able to attain degrees, many leave the scientific workforce because of the lack of career opportunities that respect the balance between having a career and a life outside of the laboratory.

Fortunately, there have been some recent changes in culture in some institutions to legitimize the idea of making allowances for women and men in the workplace (especially in academe) to accommodate such needs. For example, the ADVANCE program of the National Science Foundation has been especially important in funding efforts on campuses of research universities to effect structural changes that lead to the creation of work environments where women and men are supported in blending the demands of their work and their lives.

We know that the challenges presented above need not be the norm since we see institutions that are able to do much better:

- Institutions that have high percentages of women in engineering—for example, Morgan State University, where women received over 42 percent of such Bachelor's degrees in 2007.
- Institutions with high percentages of women in computer science—for example, Carnegie Mellon University, which was able to move from seven percent to about 40 percent entering majors between 1995 and 2001.
- Curriculum arrangements that produce different outcomes—for example, programs of "Physics First" in Rhode Island, which are generating more excitement as well as parity in physics course taking.
- Departments with more than the token woman—for example, the chemistry faculty of Purdue University, which boasts 15 women.

The question is, "what do these institutions do differently?" How do we more broadly share these effective practices? How can individual champions, departments and whole institutions be rewarded and recognized for their effective efforts?

What Can AAAS Do?

Recognition. Responding to the need to give recognition and visibility to individuals who have excelled in their efforts as mentors to students from under-represented groups, AAAS established its mentoring award, conferred first in 1991. This award served as the inspiration for the Presidential Awards for Excellence in Science, Mathematics and Engineering Mentoring program administrated by the National Science Foundation.

Defining "Normative" Behavior. An important role that a professional society plays is in helping to define what is an acceptable practice within the culture of the discipline. Through the years and on numerous occasions, the association has prescribed and clarified its position in support of equal opportunity in science and nondiscrimination in the workplace and has urged its affiliates to adopt similar positions. Such a stance helps to shape the mores of the community, defining as unacceptable behaviors that "create an atmosphere that is not conducive to the advancement of science."

Career Development. AAAS has a robust set of career-related activities coordinated across its programs and the journal *Science,* working cooperatively through a Center on Careers in Science and Technology. Through partnerships with organizations and corporations, AAAS produces materials that feature young and established women in STEM careers, telling their stories about their lives in science and beyond. These materials are among the resources that are distributed to organizations and institutions by AAAS and others as we reach into communities to help young women, along with their parents and teachers, explore the possibilities of careers in science. It is also important to tell these stories to higher education faculty.

In partnership with L'Oreal and its initiative "For Women in Science" we manage the postdoctoral awards program, giving a boost to the careers of young women scientists through grants to support their independent entry into research as well as through a program of professional development and skill building.

Education and Career Guidance. Through the support of a grant to promote STEM careers (especially those focused on energy and environment) to middle grades students, we are developing training materials and models for guidance counselors in secondary schools. By demystifying potential S&T jobs of the future and the education needed to pursue these career tracks, we are also directly addressing the stereotypes about "who can do science and engineering," allowing the opportunity to develop the talent of students who may be female, members of minority groups and/or persons with disabilities.

Capacity Building. Recognizing the need to develop organizational capacity to assess program value and effectiveness, AAAS has established its Center on Advancing Science and Engineering Capacity. Working largely with universities, AAAS assists these institutions in developing internal structures to evaluate their programs and processes and to act on the information that it gains. The Capacity Center points to research-based interventions of demonstrated effectiveness to fully develop and utilize the talents of women and men among its undergraduate and graduate students as well as in support of diversifying its faculty.

Capacity building has not been confined to formal education; for decades AAAS has worked with community-based organizations and girl-serving groups to incorporate STEM programming into the suite of informal activities that such groups provide. In the past our partnerships have included Girls, Inc. (represented here at this hearing) and Delta Research and Education Foundation of Delta Sigma Theta Sorority (a service sorority of college-educated African American women who used the AAAS-developed training models and materials to organize science-focused community activities for families). These types of informal science education opportunities have been found to be particularly effective for engaging under-represented groups in the sciences. It is a theme that is echoed in the new NAS report, *Learning Science in Informal Environments: People, Places and Pursuits.*

"The Double Bind." AAAS has played a leadership role in identifying barriers to education and careers in science, engineering and biomedicine for women who face multiple barriers including race/ethnicity and/or disability. In 1975 AAAS convened the first conference on minority women in science, the proceedings of which were published as *The Double Bind: The Price of Being a Minority Woman in Science.* The Association catalyzed the development of a national network of minority women as well and urged the collection and reporting of data disaggregated by race/ethnicity and by sex. Such data are critical to identifying barriers still encountered by these women such as their lower levels of participation within university STEM faculties, even where their levels of doctoral attainment compare favorably with males of their particular group.

Visibility. Women are active and visible participants in every aspect of the leadership of AAAS: as speakers and organizers of meetings and conferences; as leaders in the governance of the organization; and among the ranks of its senior staff. It is critically important that young women who may be asking if there is a place for them in science see examples of individuals who have made this choice, who are being successful and making a difference.

What Can the Federal Government Do?

Many researchers and program managers believe that STEM fields are not being "marketed" appropriately to girls and young women. While President Obama has articulated specific challenges where science and engineering must play a role, it is also important to provide materials (and opportunities for engagement) that demonstrate how STEM connects to addressing the real world problems we face as a nation and as a world. Consider, for example, the areas of engineering where the distribution of Bachelor's degrees in environmental and biomedical engineering awarded to women approaches that of men.

Many believe that a new call to serve for both young men and young women needs to link the critical role of education in STEM fields with the opportunity to address global concerns such as food security, clean water, climate change, clean sources of energy, and infectious diseases and other health issues. Students need examples of people who are doing this work today as well as access to opportunities for experiential learning. It is important in such efforts to prominently include women as well as men.

There is a range of laws and executive orders that pertain to colleges and universities as educational institutions as well as their role as recipients of federal funding that require fair treatment and equal opportunity. It is important that the Federal Government provide guidance and assistance to higher education institutions in their voluntary reviews of their practices to ensure that there is full access to study

and employment for women as well as men. It is important that we not tolerate discrimination in any form: in establishing environments supportive of women's education in STEM fields; in applications, hiring, salaries and so on.

In addition we need to explore the cost of pursuing STEM careers, both in terms of loans that must be repaid as well as the opportunity costs incurred through additional years of school. While access and the cost of education are problems for all, expecting a future of lower compensation is a major deterrent. With high rates of attrition and poor prospects for jobs, especially in universities, science is losing in the competition for talent. With debt and expectations of lower salaries women will vote with their feet.

Statistics. Critical to efforts to improve the recruitment and retention of women in STEM fields is identifying measures of success and "keeping score." While this certainly means evaluating individual local programs for their effectiveness, it also means maintaining the statistical base in this country that will allow us to gauge "climate" and chart progress. We need to be able to look at enrollment data by specific field of study and by each degree level; disaggregated for men and women, most certainly, but also for women from different racial/ethnic groups and by citizenship status.

We need better information on women in the S&T workforce as well as their participation as members of the STEM faculties of different kinds of institutions.

Better Practices. It was noted above that institutions vary widely in their outcomes for women in STEM, as students as well as faculty. The Federal Government needs to support the research that helps us better understand the practices that are especially effective as well as provide greater support for dissemination of these. Federal laws and infrastructure are already in place to support much of this work. Several aspects that currently apply to the National Science Foundation might be viewed for wider adoption across agencies that support STEM education and careers. In particular, the *NSF Equal Opportunity in Science and Engineering Act* and the Committee on Equal Opportunities in Science and Engineering might help inform government-wide efforts to support equal access to education and careers. In addition, in select agencies aspects of NSF's "broader impacts" criterion in award of support might also be explored.

With regard to assembling the talent needed to address America's challenges, including our long-term competitiveness, it is "all hands on deck." It is critical that the United States have access to the full talents of all of its citizens and that every effort be made to enable that. As we face pressing challenges whose solutions depend upon science and technology, we cannot afford to waste the minds and potential of women.

BIOGRAPHY FOR ALAN I. LESHNER

Alan I. Leshner is Chief Executive Officer of the American Association for the Advancement of Science (AAAS) and Executive Publisher of its journal, *Science.* From 1994 to 2001, Dr. Leshner was Director of the U.S. National Institute on Drug Abuse at the National Institutes of Health (NIH), and from 1988 to 1994 he was Deputy Director and Acting Director of the National Institute of Mental Health. Prior to that, he spent nine years at the National Science Foundation, where he held a variety of senior positions, focusing on basic research in the biological, behavioral and social sciences, on science policy and on science education. Dr. Leshner began his career at Bucknell University, where he was Professor of Psychology. His research has focused on the biological bases of behavior, particularly the role of hormones in the control of behavior. Dr. Leshner is an elected member of the Institute of Medicine of the National Academy of Sciences, and an elected fellow of the AAAS, the American Academy of Arts and Sciences, and the National Academy of Public Administration. He has received numerous awards from both professional and lay groups for his national leadership in science, mental illness and mental health, substance abuse and addiction, and public engagement with science. He received an A.B. degree in Psychology from Franklin and Marshall College and M.S. and Ph.D. degrees in Physiological Psychology from Rutgers University. He also has been awarded six Honorary Doctor of Science degrees.

Chairman LIPINSKI. Thank you, Dr. Leshner. I now recognize Dr. Kropf.

STATEMENT OF DR. MARCIA BRUMIT KROPF, CHIEF OPERATING OFFICER, GIRLS INCORPORATED®

Dr. KROPF. Mr. Chairman, Ranking Member Ehlers, thank you for the opportunity to testify before you today.

As you know, I am the Chief Operating Officer of Girls Incorporated. That is the national nonprofit that inspires all girls to be strong, smart, and bold. On behalf of Girls Inc., our 96 local affiliates, and the girls we serve, I am pleased to present our approach to advancing girls' interests, confidence, and competence in STEM fields.

In 1985, with funding from the National Science Foundation, we launched Girls Inc. Operation Smart, our program to help girls develop enthusiasm for and skills in STEM. Since that time, more than 750,000 girls have participated in this program. Our experience with Operation Smart and our research and development leads us to three important messages for you today.

First, despite gains in the number and achievement of girls and women in STEM, substantial gaps remain. Over the past 30 years, as the barriers of entry into many STEM fields have eased, women have vastly increased their proportion of academic degrees earned in STEM, as you just heard.

At the same time, however, gaps remain. Girls in the United States today grow up at a time when women have unprecedented opportunities, but they are also aware that in our society, stereotypes persist. In a 2006 Girls Inc. survey, conducted by Harris Interactive, 55 percent of girls in grades 3–12 agreed with this statement: "In my school, boys think they have the right to talk about girls' bodies in public." 44 percent of girls, half, almost half, agreed that: "The smartest girls in my school are not popular." 36 percent said: "People think girls are not interested in computers and technology." And 17 percent of girls thought it was true that: "Teachers think it is not important for girls to be good at math." And those statistics, by the way, didn't change much since an earlier survey in 2000.

This last finding leads to our second message, that informal science education is a critical strategy to address the gender gap. The National Academies recently published a report on learning science in informal settings, advising that schools should not be solely responsible for addressing the scientific knowledge needs of society, and we at Girls Inc. agree. Informal education allows students the ability to learn, to discover through prolonged, hands-on collaborative experiences, to become comfortable making mistakes, and using trial and error method to solve complex problems.

To cite just one example, at our Girls Inc. affiliate in Schenectady, New York, girls created working toy hovercrafts. They were so excited by their success that they decided to try to bring their experiment to scale. Using plywood and a leaf blower, they constructed a hovercraft that was strong enough to lift girls four inches off the floor.

And we know that our approach has an impact. Girls in Eureka, our four week STEM sports camp, increased their plans to take math courses. Their interest in science careers increased as well, and the percentage of girls who were predominantly urban minor-

ity girls, whose wish for the following school year was to do well, and be on the honor roll, increased from 38 percent to 66 percent.

At Girls Inc., we pay explicit attention to equity. We assume girls are interested in math, science, and technology. We encourage them to see themselves as scientists. When our first Robotics Lego League teams go to competitions, staff have observed it is the boys who are operating the robots on the coed teams. On our teams, and those sponsored by our friends, the Girl Scouts, girls do it all. We expect girls to succeed, and we help them to develop the same expectations of themselves.

We also include adult women role models, as they are essential in helping girls to be aware of career options, and to envision themselves in those careers someday. In 2004, we surveyed women who had previously received Girls Inc. college scholarships. Of the 85 respondents, 51 percent said: "My Girls Inc. experience inspired me to pursue my interest in science, technology, engineering, and mathematics."

My final point is that the Federal Government has a vital role to play in increasing girls' participation in STEM fields. First, continue to support the NSF's Informal Science Education Program, and the research on gender in science and engineering.

Secondly, promote informal STEM education through federally funded afterschool programs. Third, support professional development for teachers and youth workers in informal STEM education, and in gender equitable teaching methods. And finally, promote the increased enforcement of Title IX.

Thank you for doing your part through this important work of the Committee. As we say at Girls Inc., it doesn't matter where a girl is from, as long as she knows where she is going. Thank you.

[The prepared statement of Dr. Kropf follows:]

PREPARED STATEMENT OF MARCIA BRUMIT KROPF

Mr. Chairman, Ranking Member Ehlers, and Members of the Committee, thank you for the opportunity to testify before you today. My name is Marcia Brumit Kropf, and I am the Chief Operating Officer of Girls Incorporated, the national nonprofit youth organization that inspires all girls to be strong, smart, and bold®. On behalf of Girls Inc., our 96 local affiliates, and the girls that we serve, I am pleased to have the opportunity to present our approach to advancing girls' interest, confidence, and competence in STEM fields.

With local roots dating to 1864 and national status since 1945, Girls Inc., formerly Girls Clubs of America, has responded to the changing needs of girls and their communities through research-based programs and advocacy that empower girls to reach their full potential. We have a longstanding and deep commitment to preparing girls for careers they might otherwise never consider, including scientific and technical careers.

In 1985, with funding from the National Science Foundation, we launched Girls Inc. Operation SMART®, a structured approach to helping girls develop enthusiasm for and skills in science, technology, engineering, and mathematics. Since that time, more than 750,000 girls have participated in Operation SMART. Through hands-on activities, girls explore, ask questions, and solve problems, and they interact with women pursuing STEM careers. Girls Inc. Operation SMART was developed with the research-based premise that in order to increase STEM gender equity, girls need to be: 1) interested in science; 2) competent and confident in science; and 3) aware of future science careers. Our experience with Operation SMART and ongoing research and development leads us to three important messages for you today:

1. As a country, we still need to address the gender gap in STEM.
2. Informal science education is a critical strategy to address the gender gap.
3. The Federal Government must continue to play a role, alongside the private, nonprofit and educational sectors, in fostering girls' success in STEM fields.

To my first point, despite gains in the number and achievement of girls and women in STEM, substantial gaps remain.

Over the past 30 years, as the barriers of entry into many STEM fields have eased, women have vastly increased their proportion of Bachelors, Masters, and doctoral degrees earned in math and in the sciences. In 1970, women earned 0.8 percent of Bachelors, 1.1 percent of Masters, and 0.6 percent of the doctoral degrees in engineering. In 2006, the percentages were 19.5, 22.9, and 20.2, respectively.[1] The story is the same in physics, geology, and chemistry. In math, women are earning nearly half of the Bachelors and Masters degrees, and almost a third of the doctoral degrees.

Girls have now essentially closed the gender gap that has historically existed in math course-taking, and in the grades boys and girls receive in those courses.[2] Girls are also now narrowing that gap in the physical sciences.

Among SAT takers, a higher percentage of young women than young men are enrolled in honors math and science courses. In 2008, 53 percent of students who took the SAT and had taken at least four years of mathematics courses were young women; 53 percent of students who had taken at least four years of science courses were young women.[3] And notably, half of the 40 finalists in the 2007 Intel Science Talent Search were girls.

At the same time, however, substantial gaps remain. Girls continue to lag behind boys in computer science, comprising just 17 percent of students taking the Computer Science A advanced placement exam in 2008, and just 12 percent of those taking the more rigorous AB exam, virtually the same proportions as in 1997.[4] Likewise, just 35 percent of AP physics test takers were girls.

Of greater concern is the fact that gains in education have not translated into workplace parity as of yet. Women still represent fewer than one in five faculty members employed in computer science, mathematics, engineering, and the physical sciences collectively. In engineering in particular women account for just one in ten faculty members.[5] And, according to the Bureau of Labor Statistics, in 2008 women accounted for just 24.8 percent of all those employed in computer and mathematical occupations, just 6.7 percent of mechanical engineers, and just 6.3 percent of engineering managers.[6]

Girls in the United States today grow up at a time when women have unprecedented opportunities. At the same time, they are aware that, in our society, women are often viewed as sexual objects and that their skills and abilities continue to be undervalued. In a 2006 Girls Inc. survey conducted by Harris Interactive, 55 percent of girls in grades 3 through 12 agreed with the statement, "In my school, boys think they have the right to talk about girls' bodies in public." At the same time, 44 percent of girls—almost half—agreed with the statement, "the smartest girls in my school are not popular" and 38 percent of boys agreed with the statement as well. This finding is virtually unchanged from an earlier study conducted in 2000. In addition, 36 percent of girls agreed that "people think girls are not interested in computers and technology" and 17 percent of girls thought it was true that "teachers think it is not important for girls to be good at math."[7]

This last finding is especially troubling and leads to my second point about the importance of informal STEM education—for girls, in particular, AND for the lessons it can bring into the regular school classroom.

As this subcommittee is well aware, the National Academies recently published a report on learning science in informal settings, advising that schools should not be solely responsible for addressing the scientific knowledge needs of society. In fact,

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[1] National Science Foundation, Division of Science Resources Statistics. (2008). *Science and engineering degrees: 1966–2006* (Detailed Statistical Tables NSF 08–321). Arlington, VA: Author. Retrieved July 13, 2009, from *http://www.nsf.gov/statistics/nsf08321/*

[2] Freeman, Catherine E. (2004). *Trends in educational equity of girls & women: 2004* (NCES 2005–016). Washington, DC: National Center for Education Statistics. Retrieved July 14, 2009, from *http://nces.ed.gov/pubsearch/pubsinfo.asp?pubid=2005016*

[3] The College Board. (2008). *2008 college-bound seniors: Total group profile report.* New York: Author. Retrieved July 14, 2009, from *http://professionals.collegeboard.com/profdownload/Total_Group_Report.pdf*

[4] The College Board. (2009). *AP report to the Nation.* New York: Author. Retrieved July 14, 2009, from *http://www.collegeboard.com/html/aprtn/pdf/ap_report_to_the_nation.pdf*

[5] Commission on Professionals in Science and Technology (CPST). (2006). *Professional women and minorities: A total human resources data compendium* (16th Ed.). Washington, DC: Author.

[6] Current Population Survey, Bureau of Labor Statistics. (2009). *Employed persons by detailed occupation, sex, race, and Hispanic or Latino ethnicity, 2008.* Annual Averages 2008.

[7] Girls Incorporated. (2006). *The supergirl dilemma: Girls grapple with the mounting pressure of expectations, summary findings.* New York: Author.

the Academic Competitiveness Council at the Department of Education recognized informal education as one of three integral pieces of the U.S. education system (the other two being K–12 and higher education) that are necessary to ensure U.S. economic competitiveness.[8]

We at Girls Inc. agree.

First, informal science education offers a learning environment free of time limitations and test anxiety. As one participant of the Girls Inc. Eureka!® Program observed, "In Eureka science we get to do experiments every day and discuss and help our peers, but in school science you can't talk among your friends about the work or you will get in trouble."

Indeed, informal education allows students the ability to learn and discover through prolonged hands-on experiences. These experiences allow individuals to become comfortable making mistakes and using a trial-and-error method to solve complex problems. At Girls Inc. of the Greater Capital Region in New York, girls created working toy hovercrafts. They were so excited by their success that they decided to try to bring their experiment to scale. Using plywood and a leaf blower, the girls constructed a hovercraft that was strong enough to lift girls four inches off of the floor. Likewise, informal science education is more free to proceed at the pace of individuals' learning. One Girls Inc. scholarship recipient described doing the "Batteries and Bulbs" experiment. She said it took her group three afternoons to make the light bulb go on—but they did it. If the experiment had been conducted in a regular school classroom with the pressures of a tight schedule for covering specific curricula, at the end of class, the teacher would have most likely shared the solution. Her group would have learned that they couldn't make the light bulb go on themselves. At Girls Inc., they learned that they could.

Girls Inc. Eureka! is a four-week summer STEM and sports camp program for girls 12–15 held on a college campus. In Alameda County, CA, girls in Eureka!, who were predominantly urban, minority girls, increased their math course-taking plans, while control group girls' plans to take math decreased. Second-year Eureka! girls' math and science course-taking plans almost doubled. Their interest in science careers increased, and the percentage of girls whose wish for the following school year was "to do well/be on the honor roll," increased from 38 percent to 66 percent.[9]

Alarmingly, however, this study also seemed to indicate that being away from school had a positive impact on girls—both Eureka! and control girls—in terms of wanting to do math and science. For most, being back in school tended to decrease that interest.[10]

For Girls Inc. and other providers of informal STEM education, this last finding points to what school systems may have something to learn from informal providers. Girls Inc. Operation SMART is a philosophy and approach to engaging girls in STEM subjects. It allows trained Girls Inc. affiliate staff to design their own programs, relevant to the interest and ages of the girls they serve. Girls Inc. of Carpentaria (CA), for example, has an Animal Care Club, where girls study animal habitats and are responsible for the care of the animals, including Rosie, their 12-year old tarantula. Girls Inc. of Omaha (NE) has a strong partnership with the College of St. Mary where female college students meet with girls in grades 1 to 6 twice a week for two months each semester in groups of one to three girls. A fifteen-year-old graduate of the program in Omaha explained that the projects were fun, hands-on, often outside, and, she said, "We didn't have to do worksheets."

Second, girls benefit from informal girl-focused programs because gender discrimination persists, usually subtle but at times blatant. Girls Inc. sponsors eight FIRST Robotics Lego League teams, with support from Motorola. The Girls Inc. teams often find themselves the only all-girl teams in the competitions (except of course when there are teams sponsored by the Girl Scouts). But on the co-ed teams, staff observed that it was always the boys who were operating the robots. In fact, on one occasion when I had the pleasure of speaking with some members of Robot Chicks Union, a group of female FIRST Robotics competitors, they complained that on co-ed teams they were actually assigned roles such as marketing and bringing the snacks for their team.

This phenomenon plays out in classrooms as well, where girls are too often relegated to supporting roles, such as recording notes, as they watch boys perform the experiments and work with equipment.

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[8] U.S. Department of Education. (2007). *Report of the Academic Competitiveness Council.* Washington, DC.

[9] Campbell, Patricia B., Ph.D., Storo, Jennifer, Ed.M. and Acerbo, Kathryn, M.A. Math, Science, Sports and Empowerment: Girls Incorporated® Replication And Expansion Of The Eureka! Model. Executive Summary. Campbell-Kibler Associates, Groton, MA.

[10] *Ibid.*

At Girls Inc., we pay explicit attention to equity and support girls as they develop the skills and self-confidence to navigate successfully through the challenges of adolescence. In Girls Inc. Operation SMART, we assume girls are interested in math, science, and technology. We let them make big, interesting mistakes. We encourage them to see themselves as scientists. Most importantly, we expect girls to succeed, and help them develop the same expectations of themselves.

According to the National Center for Women in IT, women are more likely than men to say they entered careers in STEM as a result of encouragement from a teacher, family member, or friend.[11] While we may think of "encouragement" as "soft" or unnecessary, it is actually an important factor in women's decisions about careers. Parents are a critical part of the equation here and we help them seize opportunities to encourage their daughters in STEM. Our new Girls Inc. Thinking SMART Guide has a packet for parents, also available in Spanish, filled with resources and suggestions. For example, to determine if a home experiment is SMART, parents are asked to consider whether the activity allows girls to "use their hands, bodies, and senses for things other than writing." In contrast, an activity is probably not SMART if its primary goal is "to produce an ornament or decoration."

Encouragement increases self-efficacy, which in turn increases girls' participation in formal science classes and, later, in STEM-related careers.

Finally, women role models are essential for girls to be aware of career options and to envision themselves in those careers someday.

At an event at the White House last month, tennis great Billie Jean King spoke about the importance of female role models in sports. She said girls, "have to see it to be it." The same holds true for STEM. So, we incorporate a strong career component in our STEM programming. Girls Inc. has just completed a $2.3 million grant from the National Science Foundation for a program that connects girls with women in STEM career fields, including members of the Society for Women Engineers. And this is not just a 20 minute career day speech. This is working together over time on a substantive project, allowing for positive connections to be built.

Role models are particularly important for girls of color, but sadly minority women in science are scarce. African-American women make up just 1.5 percent of all those employed in science and engineering occupations, Hispanic women account for just 1.3 percent and American Indian and Alaska Native accounts for 0.1 percent.[12] Ironically, African-American women have been shown to express higher levels of interest in science than white women.[13] Seventy percent of the girls served by Girls Inc. are girls of color. And 65 percent come from families with incomes under $25,000. It is essential that these girls receive high quality STEM programming that will open these fields up to them.

In 2004, we surveyed women who had previously received our Girls Inc. Lucile Miller Wright College Scholarships. Of the 85 respondents, 51 percent said that "My Girls Inc. experience influenced my college experience. It inspired me to pursue my interests in science, technology, engineering, and mathematics."[14]

My final point is that the Federal Government has a vital role to play in increasing girls' participation in STEM fields. We need the help of this committee to be recognized and tapped as equal players in STEM education.

- *First, continue to support the National Science Foundation's Informal Science Education Program, and Research on Gender in Science and Engineering.* Grants through the NSF are critical to the implementation of informal science education programs like ours as well as science museums, zoos, and environmental centers. Such grants provide research-based and innovative programs the ability to continue to increase national interest in STEM fields.
- *Second, promote informal STEM education through federally funded afterschool programs.* Proven, national programs like Girls Inc. Operation SMART incorporate the latest research on girls' engagement and persistence in STEM and can and should be targeted for funding to address the under representation of girls and minorities in STEM. Ninety percent of the sites funded by

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[11] Zarrett, N. & Malanchuk, O. (2006). Encouragement from parents or teachers plays a large role in students' choice of a Computer Science major. In *Women and IT: Research on Underrepresentation.* J.M. Cohoon & W. Aspray, eds., Cambridge: MIT Press.

[12] National Science Foundation. (2007). *Employed scientists and engineers, by occupation, highest degree level, race-ethnicity, and sex: 2006.* Division of Science Resource Statistics, Arlington, VA.

[13] Hanson, S. (2004). African American women in science: Experiences from high school through the post-secondary years and beyond. *NWSA Journal* 16(1), 96–115.

[14] Girls Incorporated (2004). *Growing Up at Girls Incorporated: The GROW Study of Girls Inc. National Scholars.* New York: Author.

the 21st Century Community Learning Centers (federal afterschool program) are on school campuses.

- *Third, support professional development for teachers and youth workers in informal STEM education and in gender-equitable teaching methods.* Provide opportunities for these professionals to interact with each other and learn from each other.
- *Finally, promote increased enforcement of Title IX.* Public information campaigns are needed to raise awareness among students that Title IX covers discrimination broadly, not just sports. Title IX prohibits bias in counseling, sexual harassment in schools, and can be a tool for achieving classroom environments that are free of harassment.

In closing, according to a report of the Commission on the Advancement of Women and Minorities in Science, Engineering and Technology, there are four points at which the STEM career pipeline loses girls and women: as they enter middle school, late high school, college and graduate school, and finally in their professional life.[15] We have to be attentive to all these stages and intentional about retaining girls and women at each. Thank you for doing your part through the important work of this committee. As we are fond of saying at Girls Inc., it doesn't matter where a girl is from, as long as she knows where she is going.

BIOGRAPHY FOR MARCIA BRUMIT KROPF

Marcia Brumit Kropf joined Girls Incorporated®, the nonprofit organization that inspires all girls to be strong, smart, and bold, in the Fall of 2003. Dr. Kropf oversees the implementation of the organization's strategic plan and has direct responsibility for the National Services, Program & Training Services, Research, IT, and Human Resources departments. She heads the organization's IT Council and is leading an enterprise-wide multi-year initiative to address the needs of Latina girls aged 6 to 18. Dr. Kropf represents Girls Inc. at the K–12 Alliance for the National Council of Women in IT and just completed a two-year term as Co-Chair for that group. She is a member of the New York City Commission on Women's Issues and the Expert Advisory Panel for New Moon, as well as an advisor to the Jeannette Rankin Foundation and the Purdue University Center for Families. She also serves as Co-Chair of the COO Peer Network for the National Human Services Assembly.

Previously, Dr. Kropf spent 12 years at Catalyst, the premier nonprofit research and advisory organization working to advance women in business, as Vice President of Research & Information Services. She oversaw the Research Department, the Information Center (a special library focusing on women and work), and Catalyst's efforts to advance technologically in the 21st Century. She also led the Work and Family team of experts, the group advising companies on a range of topics including flexible work arrangements, leaves of absence, and childcare. Prior to her work at Catalyst, Dr. Kropf spent over 20 years working in public education in a variety of positions, from classroom teaching to software design, focusing primarily on curriculum design and evaluation.

Dr. Kropf earned her B.A. from Mount Holyoke College, a Master of Arts in Teaching from Oberlin College, a Certificate of Advanced Studies in Reading Education from Syracuse University, and a Ph.D. in Educational Communication and Technology from New York University.

Chairman LIPINSKI. Thank you, Dr. Kropf. The Chair will now recognize Dr. Hanson.

STATEMENT OF DR. SANDRA L. HANSON, PROFESSOR OF SOCIOLOGY, CATHOLIC UNIVERSITY

Dr. HANSON. Chairman Lipinski, Ranking Member Ehlers, distinguished Members. I am Sandra Hanson. I am Professor of Sociology at Catholic University. I have been doing research on girls in science for several decades now, and it is a pleasure to be here.

One of the myths about girls in science is that from the time they start school, girls are less interested in science than boys. In my research and that of others, we show girls start out with equal

[15] "Land of Plenty: Diversity as America's Competitive Edge in Science, Engineering, and Technology." September 2000.

interest and abilities in science. Things start changing, though, as early as the second grade.

One NSF study found that when second grade girls and boys draw pictures of scientists, they draw a white male in a lab coat. Usually the scientist is alone with a beaker or a test tube, and when they draw a woman scientist, she is fairly severe and unhappy looking. I have found that the departure from STEM even happens for very talented girls who show promise in science.

What about the nature versus nurture argument? The notion that boys are naturally better at math and science, continues to be a popular one. A recent study looked at 3,000 pairs of British twins at nine, 10, and 12 years of age. They looked at genetic and environmental factors that affected math and science achievement. They found no difference in math and science achievement at nine, 10, and 12, and more importantly, no difference in the influence of genetic and environmental factors on the boys and girls at these ages. So they concluded it is more about attitudes than aptitude.

So what is going on? Why are women leaving STEM? One of the issues is textbooks. If students don't see images in textbooks of people that look like themselves, they can't connect. Science textbooks are improving, but they show many more images of male scientists. One NSF-funded study at Colorado State looked at elementary school science textbooks, and found 66 percent of the images were of men, and 34 percent were of women.

But there has been progress in STEM education. Recently, for the first time ever, two women, young girls, won the grand prizes in the prestigious Siemens National Math and Science Competition. And my research shows there is more progress in STEM education than occupations, so that in 2006, women earned 20 percent of the Ph.D.s in engineering, but they were only 12 percent of the employed engineers. In some areas, girls get more degrees than boys. Chemistry and biological sciences are two of them. Employers can no longer argue that there is a shortage of qualified female science talent.

One of the things that is implicit in my research is that you can't just talk about girls in science. Science is not just a male culture. It is a white male culture. So that an important lesson from my work is that men and womens' experiences in science vary across social class and race groups. When I looked at African-American women in science recently, I found tremendous interest and engagement, and many people have missed this, including social scientists, who think that the race and gender disadvantage is a double disadvantage for them, thus, they must not be interested.

Although I have found a loss of science talent amongst young women, I am quite optimistic. I see more interest. I see the interest amongst minority women. I also have looked at the role of sport as a resource for young women. Sport encourages independence, teamwork, competition, the same traits that tend to be associated with women's success in the male domain of science. So, female athletes have an advantage in science over non-athletes, and so young girls who are given an early opportunity in sport might be less intimidated and more prepared for the culture of the science classroom.

I am also encouraged by evidence from single-sex STEM education. Many women scientists today have spent at least some of

their time at single-sex universities. In 2006, several researchers at the University of Michigan studied the progress of girls in two schools, almost identical math curriculum, but one was coed and one was single-sex. And at the end of the year, they measured their progress in math, and found those in the single-sex school outscored those in the coed school by over 50 percent.

There are things that work. There are things that we can do. My time is running short, but I know that the new practice guide published by the National Center for Education Research, entitled "*Encouraging Girls in Math and Science*," offers very specific things for schools and teachers, in terms of increasing girls' participation and interest in science.

Guides such as this one should be integrated into our curriculum. Girls deserve equal access to STEM, and we can do better, and I think both boys and girls would benefit from improving our STEM education.

Thank you.

[The prepared statement of Dr. Hanson follows:]

PREPARED STATEMENT OF SANDRA L. HANSON

Chairman Lipinski, Ranking Member Ehlers, and distinguished Members of the Subcommittee, I am Sandra Hanson, Professor of Sociology at Catholic University. I have been doing research on girls in science for several decades. It is a great compliment to be able to share my research with you today. Thank you for the opportunity to testify about encouraging female students in STEM fields.

Today I would like to address three issues regarding research on girls in science education: an overview of my research on the topic, the current status of research (in general) on girls in STEM; and ideas about disseminating research findings.

OVERVIEW OF MY RESEARCH: WHAT MY RESEARCH REVEALS ABOUT THE FACTORS THAT SHAPE GIRLS' INTEREST AND PARTICIPATION IN STEM.

Findings from my research show that *young girls do not start out with low achievement in STEM.* Early in the high school years, however, many girls experience the beginning of a departure from STEM typified by enrollment in fewer STEM courses, lowered achievement, and increasingly negative attitudes.[1] This "chilling out" occurs even for young women who have shown promise and talent in science. My research confirms that young women's increasing presence and success in STEM education is happening at a faster rate than in science occupations. In 2006, women earned 20 percent of Ph.D. Engineering degrees but they represented only 12 percent of employed Engineers.[2] In some areas (e.g., Bachelor's degrees in chemistry and in biological sciences) young women earn more degrees than young men. Employers can no longer argue that there is a shortage of qualified female science talent. We need to do more to make sure that all young people, regardless of sex, have a chance to succeed in STEM education. It is just as important that young women who acquire qualifications in STEM have equal access and opportunity in STEM occupations. Although I cannot summarize all of my research here, I briefly discuss a number of issues below, including: STEM as an elite area of the U.S. (and international) education and occupation systems, the intersection of gender and race in creating STEM talent, structural barriers and selection processes that filter women (even talented women) out of STEM, measurement of girls' STEM experiences, and sources of optimism about the future of girls in STEM.

STEM as an elite. My research suggests that we *view STEM as an increasingly powerful elite.* The study of elites has historically been an important part of social science theory and research. Elites have been described as those occupying powerful and influential positions in government, corporations, and the military. These elites

[1] See data from NCES (Appendix Table 1), NSF, and NCER (National Center for Education Research, Institute of Education Studies) (Figures 1 through 4) on gender and STEM achievement from kindergarten through post-secondary school in the Appendix.

[2] NSF. 2009. Women, Minorities, and Persons with Disabilities in Science and Engineering (*http://www.nsf.gov/statistics/wmpd*).

share interests and attitudes, and have networks which work to encourage and include some and discourage and exclude others. In a technologically advanced, postmodern, global society, the status, power, shared interests and powerful networks of those in STEM suggests that they must be considered as members of the new elite. One of the most distinguishing features of the science elite (historically and currently) is the shortage of women and non-whites. In spite of the progress that women and minorities have made in STEM education and occupations, the culture of science continues to be a white male culture that is often hostile to women and minorities. In a technologically advanced society, it is the work of scientists that will determine our future. The need for a talented, diverse, well-educated workforce can no longer be questioned.

The intersection of gender and race. Implicit in my research is the notion that *STEM is not just a male culture; it is a white male culture.* I am happy to hear that the subcommittee will also be holding hearings on minorities in science. An important lesson from my work on women in STEM is that one cannot just talk about "women" or "men" in STEM. Men and women across race and social class statuses have very different experiences in STEM. Gender cultures vary tremendously across race groups and my recent research on African American women in science suggests a considerable interest and engagement in science. Many people assume a double disadvantage associated with race and gender for young African American women as they enter the STEM education system. It is important that researchers not make any assumptions about the effect of being female or black without considering how these statuses might converge. In other words, we need to avoid talking about "women" in science. Instead, we should be looking at the experiences of different groups of women. Because of the unique gender system in the African American community, these young women actually have some advantages in the STEM system.

In a related way some of my research has focused on the unique science experiences of another racial/ethnic group—Asian Americans. My surveys with hundreds of Asian American youth reveal considerable complexity in their science experiences in spite of stereotypes about the "model" minority. Both Asian American girls and boys outperform white youth (even male white youth) in science. This finding is an interesting one given the evidence of traditional gender systems in many Asian American cultures. My research does show, however, that Asian American girls do not have the same level of science achievement as Asian American boys. Although Asian (and Asian American) culture can be seen as a model for creating interest and achievement in science (for girls as well as boys), the youth in my survey reported considerable stress and anxiety associated with overwhelming familial pressure towards success in science.

The next ethnic group that I will focus on in my examination of the confluence of race and gender in STEM is Latino youth. There is a dearth of research on the experiences of Latino youth in the U.S. STEM education system in spite of the fact that Latinos are the fastest growing ethnic/racial minority in the U.S. Both Latino men and women are under-represented in STEM. Stereotypes about Latinos involving "marginalized populations," "immigrants," and "second-language users" as well as the assumption that the Latino experience is at odds with the larger U.S. culture work against these young people in the science education system. I hypothesize that Latino women will have considerable interest and potential talent in science in spite of stereotypes involving "marianismo" which see them as submissive, subservient, and thus uninterested in STEM. There is a growing, but limited research on Latino women that shows that they are breaking these old stereotypes and increasingly earning graduate degrees and higher salaries in professional (and science) areas.

Structural barriers and selection processes. My research also shows that *the problem of talented young women leaving science (and of a shortage of women in science in general) says less about the characteristics of young women and more about structural barriers and selection processes.* These processes directly affect STEM achievement through gender discrimination but they also affect achievement indirectly through the transmission of "gendered" socialization and unequal allocation of science resources in families, schools, and the media. My research supports structural theories of how education systems work. Here, individuals are not necessarily free to achieve according to their talents but rather are subject to systems that identify, select, process, classify, and assign individuals according to externally imposed (in this case biological sex) standards. Students then develop their expectations toward their future around these observed constraints.

Interestingly, my work shows that these processes often work in a subtle way that students and teachers may not be aware of. Instead, members of a society are largely in agreement on cultural ideas regarding gender. They share in this "world taken

for granted'' regarding gender and science which becomes so routine that it is seldom questioned. Studies of young girls show that they think they are making individual choices, but those choices tend to reproduce gender structures. In a similar manner, work by the Sadkers has shown that teachers (in science and other classes) teach male and female students differently without being aware of these behaviors.

My work supports the stereotype threat theory in psychology by showing that many young African American women adjust their behavior to stereotypes about race, gender and STEM. These adjustments sometimes result in leaving STEM fields. In addition, the stress of trying to resist stereotypes actually results in reduced STEM achievement.

Measurement of girls' STEM experiences. An important finding coming out of my recent research involves the *way in which we measure girls' STEM experiences.* Social scientists need to think carefully about their methods, measures, and samples when making conclusions about gender and science. Gender continues to be a sensitive topic in U.S. culture and standard methods of data collection via surveys often result in responses that are socially desirable and culturally biased. In my recent book *Swimming Against the Tide,* I used a series of vignettes to provide insight into STEM attitudes and experiences. Instead of asking young women directly about their STEM experiences, I asked the young women to respond to a story of a young woman and her experience in the science classroom. I also allowed the young women to answer unstructured, open-ended questions about their STEM experiences so that they could describe these experiences in their own words. When the young women (both white and African American) were asked about a ''chilly'' climate in the science classroom for women like those in the vignette (as opposed to for themselves), they were twice as likely to report this problem.[3] Additionally, the open-ended responses from the young women provided rich insights into the difficulties that young women have in the science classroom. One young African American woman talked about her love of science, the science camps her family had sent her to, and the posters of African American scientists hanging in her bedroom. But when this young woman entered the science education system, she felt like she was ''swimming against the tide.'' Another young African American woman reported that the science teachers ''looked at us like we were not supposed to be scientists.''

Another factor in the research process has to do with the samples that we use. STEM research based on non-representative samples of youth must be considered cautiously. Although findings from this research might help in formulating concepts and theory, it should not be (but often is) generalized. In sum, my research shows that the methods we use to study gender and STEM need to be carefully considered. The ultimate goal of researchers should be to use multiple methods and representative samples.

Sources of optimism. Although my research shows a loss of talented young women from the STEM pipeline, my *research results have also provided me with considerable optimism* about the future of women in science. Some of the sources of optimism come from:

- The gains that women are making in STEM (course taking, achievement scores, degrees, and jobs). Recently, for the first time ever, girls were awarded both grand prizes in the prestigious Siemens national math and science competition.
- The high level of interest and engagement in STEM among young minority women and the important role of minority families and communities in creating and maintaining this interest (schools and educators need to be aware of this resource).
- The important resource that sport provides in enhancing young women's science access and achievement. My research has shown that sport encourages independence, teamwork, and competition—the same traits that tend to be associated with women's success in the male domain of science. Female athletes have an advantage in science over non-athletes. Young girls who are given an early opportunity to be involved in sport may well be less intimated and more prepared for the culture of science classrooms and work settings.
- The increasing body of research addressing issues regarding gender and STEM.

[3] See Table A.3.3 in the Appendix for my findings using the Vignettes presented in Hanson (2009), *Swimming Against the Tide.*

- The ongoing support of research and programs on girls in STEM by organizations such as The National Science Foundation and the cumulative knowledge (as well as applications) resulting from this support.
- The increasing evidence that there is a large and talented pool of women to fill the increased demand in STEM. Additionally, the compelling evidence that the absence of women and minorities in STEM robs employers of diverse strategies, skills, and competence that translate into economic gain in an age of global markets.
- My review of the education literature and surveys of young women show a clear direction for how we can change science education to make it more inclusive.[4] Other research supported by NSF concurs and, importantly, suggests that these changes would benefit all youth.[5] The young women in my sample suggested, e.g.: better preparation in STEM in the early years and access to advanced STEM tracks in the later years, making science more accessible, better trained and motivated teachers, smaller classes, more work in groups (cooperative learning), more hands-on experiences (and an active laboratory component), more gender and race diversity in science teachers and curriculum (especially textbooks), high expectations for all students, special programs to encourage women and minorities in science, and more access to mentoring and networking.

THE CURRENT STATUS OF RESEARCH ON THE INVOLVEMENT OF GIRLS IN STEM. WHAT DO WE KNOW?

In the paragraphs below I briefly highlight some of the recent research on girls in STEM. I begin the discussion with research compiled by NSF on myths associated with girls in STEM.

Myths. The NSF Research on Gender in Science and Engineering program has published the following myths about girls and science based on findings generated by their funded research:[6]

1. *From the time they start school, girls tend to be less interested in science than are boys.* In fact, boys and girls start out with equal interest and abilities in science. Things start changing, though, as early as the second grade. One study showed that when second grade boys and girls draw a scientist, most draw a while male in a lab coat. The scientist is generally shown to be alone with a beaker or test tube. When they draw women scientists she looks severe and unhappy.
2. *Classroom interventions that work to increase girls' interest in STEM turn off boys.* Researchers have found that what works to increase girls' interest in STEM also tends to increase boys' interest in STEM.
3. *Science and math teachers are not biased toward male students.* Research shows STEM teachers continue to interact more with boys than girls. They often encourage independence for boys and requests for help from girls.
4. *Parents can't do much to motivate girls when they are not interested in science.* Research shows that the support of parents is crucial to a girl's interest in STEM. Parents can make girls aware of STEM careers and their relevance. They can help in planning the courses and preparation which are required for a STEM career.
5. *Changing the STEM curriculum at the college level might water down important STEM course work.* The idea of having to "weed out" weaker students tends to discourage young women in STEM. One researcher found that young women with B's in STEM classes are likely to perceive these as inadequate and drop out. Young men with C's, on the other hand, were more likely to persist in the class. Changes in STEM curriculum (e.g., working in pairs on programming in entry level computer science and engineering courses) contributes to greater retention for both men and women.

The National Science Foundation provides resources for teachers (and parents) in each of these areas of STEM education.

International trends. Although women are under-represented in many science systems around the world, some countries have been more successful in creating gender

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[4] Hanson, S.L. 2009. *Swimming Against the Tide.* Philadelphia: Temple University Press.
[5] National Science Foundation. 2007. Back to School: Five Myths about Girls and Science. (Press Release 01–108).
[6] *http://www.nsf.gov/news/news_summ.jsp?cntn_id=109939*

equity than others. Countries that have made great progress in this area include New Zealand, Iceland, Finland, Albania, and Thailand. Some scholars have suggested that we examine science education practices in these countries and attempt to implement successful strategies here.[7] Data from TIMSS (Trends in International Mathematics and Science Study) show that in the U.S. boys score higher than girls on fourth grade math and science scales. There are no sex differences on these scales in many of the countries examined. In others, girls score higher than boys.[8]

The importance of nurture over nature. The notion that boys are "naturally" better at math and science continues to be a popular one for many. A recent study on 3,000 pairs of British twins (at nine, 10, and 12 years of age) informs the nature vs. nurture debate in STEM. The researchers were able to examine the genetic and environmental influences on science ability. They found that there were no differences in standardized math and science achievement scores between boys and girls at any age. The researchers found no difference between the boys and girls in how they were influenced by genetic and environmental factors. Given these findings the authors conclude that causal factors influencing science achievement have more to do with attitudes than aptitude.[9]

Media and image of scientists. Young people often have a negative image about scientists. Many of the young women in my survey resisted science because they thought it was "dumb," "not fun," "boring," for "bookworms," "geeks," and "nerds."[10] Unfortunately, there are a considerable number of negative stereotypes about science. Not only is science seen as being for old white males, but it is also perceived as being boring, and those with an interest in science are sometimes labeled as geeks and nerds. One researcher asked science teachers to draw a picture of scientists using a Draw a Scientist Test (DAST) and discovered that these teachers often view scientists in the same negative way. The pictures tended to portray scientists as serious, ominous, lonely people.[11]

Textbooks If students don't see images in textbooks of people that look like themselves, they cannot connect. Science textbooks are improving but they continue to disproportionately show images of male scientists. Recent NSF funded research at Colorado State University found that 66 percent of images in elementary science textbooks were male and 34 percent were female.[12]

Evidence from single-sex STEM education Research has shown the success of single-sex girls' schools in recruiting young women into STEM courses. A disproportionate number of women scientists have spent time in single sex colleges. The presence of a critical mass of women has been suggested to be an important ingredient for this success.[13] In 2006, researchers at the University of Michigan studied the progress of girls in a single-sex and coed school in similar math classes. When the researchers examined the math proficiency scores for these two groups of women, they discovered that the young women in the single sex school outscored those in the coed school by over 50 percent.[14]

Resources Girls have fewer out-of-school science experiences than do boys. Researchers stress the importance of exposing girls to out-of-school programs at an early age. Successful programs such as "The Magic of Chemistry" program sponsored by the University of Missouri tend to involve hands-on activities, role models, emphasis on practical applications, and equitable learning environments for girls.[15]

HOW CAN DISSEMINATION OF THESE RESEARCH FINDINGS BE IMPROVED SO THAT FORMAL AND INFORMAL EDUCATORS AND EDUCATION POLICY-MAKERS IMPLEMENT BEST PRACTICES?

We have a perfect opportunity to increase the dissemination of research on best practices for girls in STEM. President Obama's economic stimulus package involving federal research monies has given the green light to increasing our knowledge about science education. Discussions about rigorously applying Title IX to STEM education

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[7] Davis, H. 2009 (*http://www.kon.org/urc/v7/davis.html*)

[8] Lamb, T.A. and R. Bybee. 2005 (*http://www.asanet.org/footnotes/jan05/fn10.html*).

[9] Haworth, C., Dale, P., Plomin, R. 2009. Sex differences and science: the etiology of science excellence. *Journal of Child Psychology and Psychiatry* DOI: 10.111/j.1469–7610.2009.02087.x

[10] Hanson, S.L. 2009. *Swimming Against the Tide.* Philadelphia: Temple University Press.

[11] See research by Vinchez-Gonzalez, J.M. and F.J.P Palacios. 2006. "Image of science in cartoons." *Physics Education* 41(3): 240–49, and McDuffie (2001) (*http://proquest.umi.com/pqdlink?Ver=1&Exp=07-13-2014&FMT=7&DID=73462424&RQT=309&clientId=31807&cfc=1*)

[12] *http://www.cmmap.org/scienceEd/colloquium/colloquium08/April_Biasiollia.ppt*

[13] See Hanson, S.L. (2009) *Swimming Against the Tide* for a brief review of this research.

[14] *http://sitemaker.umich.edu/johnson.356/math___science_education*

[15] Tucker, S.A., D.L. Hanuscin, and C.J. Bearnes. 2008. "Igniting girls' interest in science." *Science* 319: 1621–22.

(as in sport) are beginning. This is a tremendous opportunity for organizations such as NSF (National Science Foundation), WEPAN (Women in Engineering Proactive Network), NCES (National Center for Education Statistics), the NSB (National Science Board), NRC (the National Research Council) and others who collect data and fund research and programs on girls in STEM. These organizations have considerable knowledge and expertise on best practices. We know a lot about the changes we need to make in STEM classrooms. Only with the assistance of the U.S. Department of Education and mandated science standards can we assure that these resources would be required tools for all science teachers. The new practice guide by the National Center for Education Research (''Encouraging Girls in Math and Science'') offers five recommendations for schools and teachers for increasing girls' participation and interest in science. Guides such as this one need to be integrated in a routine way into U.S. STEM programs. Girls deserve equal access to STEM. The Title IX legislation brought about tremendous change and improvement in young women's access to sport in public schools by requiring evidence of progress toward equity. We could do the same in science. Both boys and girls would benefit from improving our STEM education.

Mr. Chairman, this concludes my remarks. I would be happy to answer any questions.

APPENDIX: Tables and Figures

Appendix table 1-2

Average mathematics scores of students in kindergarten and grades 1, 3, and 5, by student and family characteristics: 1998, 2000, 2002, and 2004

Student/family characteristic	Fall 1998 kindergarten	Spring 2000 grade 1	Spring 2002 grade 3	Spring 2004 grade 5	Gain from kindergarten to grade 5
All students	22	39	91	112	89
Sex					
Male	22	39	93	114	92
Female	22	39	89	110	87
Race/ethnicity					
White, non-Hispanic	25	43	97	118	93
Black, non-Hispanic	19	33	79	99	80
Hispanic	19	36	85	108	89
Asian	25	39	94	118	93
Other[a]	20	38	86	107	86
Mother's education					
<High school	17	29	75	95	79
High school diploma	21	37	86	107	86
Some college[b]	22	39	92	113	90
Bachelor's or higher degree	28	47	103	125	97
Poverty status[c]					
Below poverty threshold	18	31	78	99	81
Above poverty threshold	24	42	95	116	92

[a]Includes non-Hispanic Native Hawaiians, Pacific Islanders, American Indians, Alaska Natives, and children of more than one race.
[b]Includes vocational and technical education.
[c]Federal poverty thresholds define households below poverty level based on household income and number of household members.

NOTES: Early Childhood Longitudinal Study (ECLS) mathematics scale ranged from 0 to 153. In 2004 followup for ECLS kindergarten class of fall 1998, 86% of cohort was in grade 5, 14% was in a lower grade, and <1% was in a higher grade. For simplicity, students in ECLS followups referred to by modal and expected grade, i.e., first graders in spring 2000 assessment, third graders in spring 2002 assessment, and fifth graders in spring 2004 assessment.

SOURCES: National Center for Education Statistics, ECLS, fall 1998 and spring 2000, 2002, and 2004; and National Science Foundation, Division of Science Resources Statistics, special tabulations.

Science and Engineering Indicators 2008

Table A.3-3: Multiple Classification Results Showing Means (and Deviations from Sample means) on Science

Variables for Young Women by Type of Vignette†

	Science Outcomes	
	Has This Ever Happened to You	Others Like Woman in Vignette Don't Feel Welcome in Science
Vignettes		
A. Sample: African American Women		
1. Girl in Vignettes: African American		
• Race as issue	.31 (.06)	.52 (.12)
• Gender as issue	.16 (-.08)	.53 (.14)
• Neutral	.53 (.29)	.63 (.23)
2. Girl in Vignettes: White		
• Gender as issue	.21 (-.03)	.35 (-.05)
B. Sample: White Women		
1. Girl in Vignette: African American		
• Race as issue	.16 (-.07)	.36 (-.04)
• Gender as issue	.18 (-.06)	.36 (-.03)
• Neutral	.36 (.11)	.39 (-.01)
2. Girl in Vignette: White		
• Gender as issue	.18 (-.06)	.31 (0.08)
Mean across groups	.24	.40
F	9.95*	5.03*

* Anova model is significant at .05 level.

† Higher score indicates greater support for the student which, in general measures problems/discomfort in science,

Table: SAT Table A.3-3

Figure 1. Percent of degrees awarded to women by major field

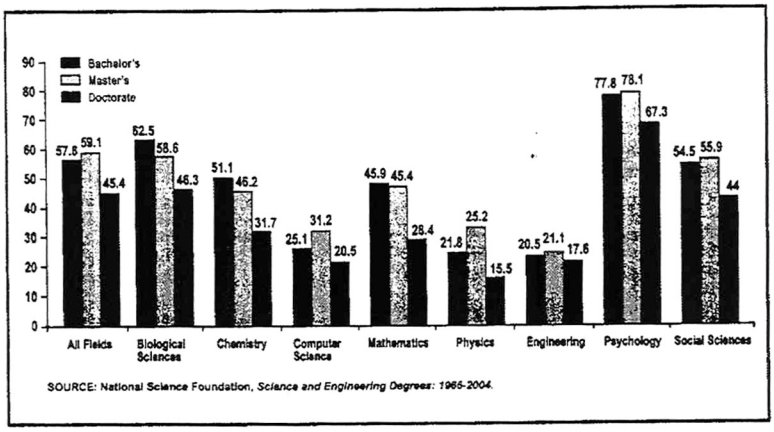


Figure 2. Percent of public high school graduates who completed various mathematics and science courses in high school, by gender: 2000

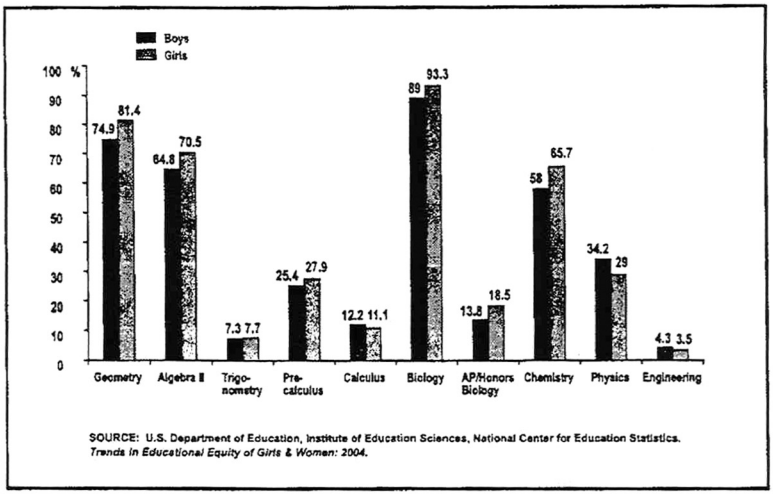


Figure 3. NAEP mathematics scores by highest course completed and gender: 2005

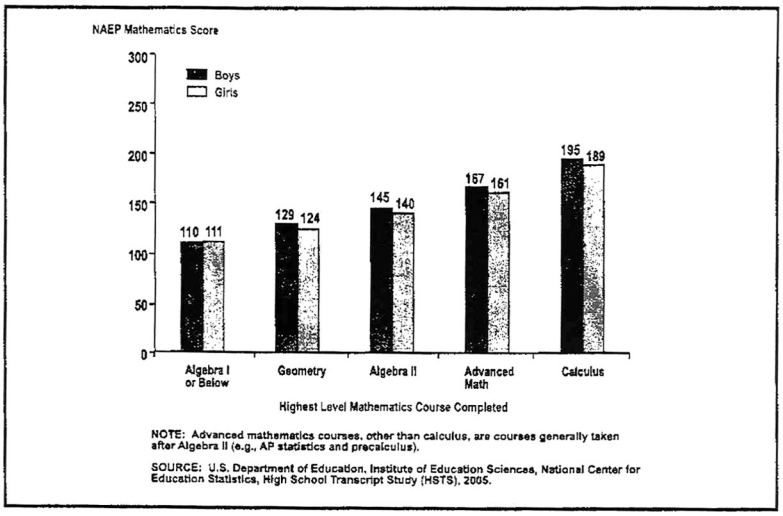
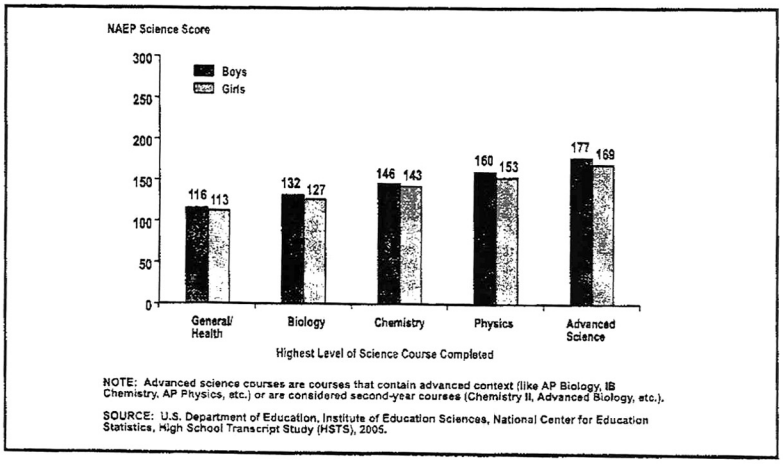


Figure 4. NAEP science scores by highest course completed and gender: 2005



BIOGRAPHY FOR SANDRA L. HANSON

Sandra L. Hanson is Ordinary Professor of Sociology and Research Associate at the Life Cycle Institute, The Catholic University of America. Dr. Hanson's research examines the gender structure of educational and occupational systems in a comparative context. Her work has been supported by six grants from the National Science Foundation. Dr. Hanson has authored numerous research articles appearing in journals including, *Sociology of Education, Journal of Women and Minorities in Science and Engineering,* and *European Sociological Review*. Her new book, entitled *Swimming Against the Tide: African American Girls in Science Education* (Philadelphia: Temple University Press: 2009), examines the experiences of African American girls in the science education system. Dr. Hanson's earlier book *Lost Talent: Women*

in the Sciences (Temple University Press: 1996) was a culmination of her research on the loss of talented young women in the science pipeline. Dr. Hanson received a Fulbright award for teaching and research at the Jagiellonian University in Krakow Poland in 1997. Her work there involved comparative analyses of gender in Poland and the U.S.

Chairman LIPINSKI. Thank you, Dr. Hanson. The Chair will now recognize Ms. Bogue.

STATEMENT OF MS. BARBARA BOGUE, CO-FOUNDER, CO-DIRECTOR, SWE AWE PROJECT; ASSOCIATE PROFESSOR OF ENGINEERING SCIENCE AND MECHANICS AND WOMEN IN ENGINEERING, PENNSYLVANIA STATE UNIVERSITY

Ms. BOGUE. I am speaking today for the Society of Women Engineers, founded in 1950 as a 20,000 member educational and service organization that empowers women to succeed and advance in the field of engineering.

First, I would like to thank the Subcommittee for providing this opportunity and I really appreciated your comments, so I should start out by saying, Mr. Chairman, Mr. Ranking Member and Members of the Subcommittee.

I will focus my comments on the need for improved assessment and evaluation practices, and the specific challenges that we face in our effort to increase the numbers of girls and women entering and succeeding in STEM-related fields.

I will emphasize engineering. That is my primary experience and knowledge, but the basic assumptions and recommendations really can apply across STEM fields in which women are under-represented.

We know that women are graduating from high school and prepared to enter engineering. High school girls take 47 percent of all AP calculus tests, and 31 percent of AP physics tests, so the real question is not whether women can do engineering. It is, "Why aren't they doing engineering, and how can we get them there?"

One key is a better understanding of what works and what does not. As Director of Women in Engineering, I developed the Women in Engineering Program at Penn State, and I developed an orientation in our bridge program that yielded the highest retention rate of any program in the College of Engineering. For that, I was recognized with the Presidential Award for Excellence in Science, Mathematics, and Engineering Mentoring.

Developing an assessment plan to measure the success of the program with Rose Marra, who is co-founder and co-Director of the AWE Project, which I will talk about in a bit, helped me understand what was working and led to the realization that the need for help in creating good assessment and evaluation is a universal need among programs with lean budgets and staff.

So, we have created the Assessing Women and Men in Engineering Project, which is funded by NSF's Research on Gender and Science in Engineering Program, to develop survey tools that measure program effectiveness, and allow comparisons of outcomes among programs. We have more than 50 of these tools now, surveys along with a lot of capacity-building tools. AWE moved in to the Society of Women Engineers to sustain the project's many projects and services. A list of current AWE products is submitted for the hearing record.

Assessment is essential for success, and funders have a role to play. The Federal Government should require meaningful assessment of funded activities, aimed toward the goal of broadening participation. Federal Title IX reviews, like those conducted by NASA, are an effective tool for identifying activities that would benefit from added scrutiny.

There are many ways to break down barriers to the recruitment and development of women in STEM, in addition to having better assessment of the programs. I will focus on three.

First, applying the research to practice is essential for success. Basic research, through programs like NSF GSE is a critical tool for increasing the numbers of women in engineering and other STEM fields.

Second, climate studies are important in uncovering barriers for women in engineering. Unwelcoming classrooms, outdated teaching styles, a lack of accommodation for different social or cultural experiences, a lack of good advising, can all create an environment that students decide to leave, rather than thrive in. This affects all students, men and women.

Our results, the AWE Project results, and other findings belie the postulation that women do not pursue engineering because they are not interested, or don't have the talent. Rather, they indicate that women who have the talent and the interest are being turned off by how the discipline is being presented.

Finally, sustained and targeted funding is necessary. Funding for basic research, funding to design and implement programs, and funding to support individuals.

In conclusion, we would like to recommend the following: Sustain and target funding for programs and activities that focus on attracting and retaining women in STEM careers and remove institutional barriers to their success, fund basic research related to those goals, review federal funding requirements and set guidelines to ensure that funded programs address national priorities that we have all talked about here today, and attract a diverse population. Support the continuation of federal Title IX reviews, to increase understanding of the issues that inhibit full participation of women in STEM at the college level. And finally, support women who wish to pursue engineering degrees. Reward institutions that are successful in increasing the number of women studying STEM disciplines.

Forty years ago, the first humans set foot on the Moon. We achieved this because we had the national will to achieve that goal, but we also supported it financially. One example is the *National Defense Education Act,* which ensured an innovative and productive engineering workforce that could do the work to get there.

President Obama has set out an equally ambitious goal to increase R&D funding to levels exceeding those of the Space Race. To achieve full participation of women and other under-represented groups in this bold new endeavor requires a bold commitment. We at the Society of Women Engineers look forward to and support your efforts in this regard.

Thank you for the opportunity.

[The prepared statement of Ms. Bogue follows:]

PREPARED STATEMENT OF BARBARA BOGUE

Mr. Chairman, Mr. Ranking Member, and Members of the Subcommittee:

Good morning. My name is Barbara Bogue. I am an associate professor of engineering science and mechanics and women in engineering at Penn State. I am also the Co-Founder and Co-Director of the Society of Women Engineers' Assessing Women and Men in Engineering (AWE) Project. I am Past Director of Penn State's Women in Engineering Program and received a Presidential Award for Excellence in Science, Mathematics and Engineering Mentoring (PAESMEM) recognizing my work as Director in increasing the retention of women in engineering. I also serve on the Advisory Group for the American Association of University Women (AAUW) Project on Women and Girls in Science, Technology Engineering and Mathematics (STEM), on the National Girls Collaborative Extension Service Project Champions Board, and as an equity expert for the National Academy of Engineering Center for the Advancement of Scholarship in Engineering Education. I am speaking today on behalf of the Society of Women Engineers (SWE) and not on behalf of my employer or any of these groups.

First, I would like to thank the Subcommittee for providing me with this opportunity to talk about how to encourage the participation of female students in STEM fields. This is important to our nation's future as a global leader in innovation. As you know, the National Academies' report, *Rising Above the Gathering Storm*, concluded that increasing the number of students entering and succeeding in the STEM fields was critical to prepare our nation for the future.[1] A more recent National Academies report entitled *Beyond Bias and Barriers: Fulfilling the Potential of Women in Academic Science and Engineering,* also reminds us that women and girls still face barriers to their success in the STEM fields, and more attention must be paid to this issue.[2]

I will focus my comments on the need for improved assessment and evaluation practices of programs serving women in STEM, and on some specific challenges we face in our effort to increase the numbers of girls and women entering and succeeding in STEM-related studies. I will be emphasizing engineering, because that is where my primary experience and knowledge lie, but the basic assumptions and recommendations can apply throughout many disciplines in STEM fields in which women are under-represented.

While there are some similarities among the various STEM fields, there are also many differences. It is important to note that engineering and science are different fields. We must recognize that, while they have common recruitment and retention challenges, the different disciplines each face unique challenges. Discussions and statistics that treat all STEM disciplines as one mask real issues. For example, 2006 National Science Foundation (NSF) statistics show that women received almost 50 percent of science and engineering Bachelor's degrees in 2005–06.

Taken on face value, these statistics make it look like there is no problem. If we break out engineering, however, the percentage of women receiving degrees is a very low 18 percent. And even within engineering, there are great variations. Environmental, bio and chemical engineering—all fields related to biological sciences—have high percentages of women at 40 percent, 37 percent and 34 percent respectively. Unfortunately, these are relatively small disciplines in terms of numbers enrolled. Mechanical and electrical engineering, on the other hand, are disciplines that traditionally have the largest populations of students, but have very low percentages of women at 11 percent and 12 percent respectively. Computer engineering, another field critical to national competitiveness, has only 11 percent.[3] I am submitting some graphs for the hearing record that illustrate these statistics.

These differences have real implications for policy makers and STEM practitioners. A recent study by Sonnert and Fox finds that it is advisable "to take field differences into account and to tailor efforts and initiatives to the situation in specific fields, rather than simply targeting 'women in science' or 'women in science and

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[1] National Academy of Sciences, National Academy of Engineering, Institute of Medicine Committee on Prospering in the Global Economy of the 21st Century: An Agenda for American Science and Technology. (2006). *Rising Above the Gathering Storm: Energizing and Employing America for a Brighter Economic Future.* Washington, D.C. : National Academies Press.

[2] National Academy of Sciences, National Academy of Engineering, Institute of Medicine Committee on Science, Engineering, and Public Policy (COSEPUP). (2009). *Beyond Bias and Barriers: Fulfilling the Potential of Women in Academic Science and Engineering.* Washington, DC: National Academies Press.

[3] Commission of Professionals in Science and Technology. (2009). *Professional Women and Minorities: A Total Human Resources Data Compendium.* Washington, D.C.

engineering' in toto."[4] A recent National Academies study, *Gender Differences in Critical Transition Points in the Careers of Science, Engineering, and Mathematics Faculty,* did not take such research into account, and examined only select STEM fields to conclude that there is relatively no problem at critical transition points for women in academic careers.[5] This study is an example of the way that treating all disciplines collectively conceals problems in individual STEM fields.

Recruiting women into engineering, a field in which they are under-represented, should be pursued as one clear path to increasing the overall yield of engineering degrees granted in the U.S. We know that women graduating from high school are prepared to enter engineering. High school girls take 55 percent of all Advanced Placement tests, including 47 percent of all calculus tests, 47 percent of chemistry tests, 31 percent of physics tests and 17 percent of computer science tests.[6] So the real question is not whether women can do engineering. It is: How can we attract them into STEM careers?

One key to answering this question is a better understanding of what is working and what is not working in our national efforts to attract girls and women into STEM fields. And, although different efforts might be required for particular STEM fields, certain activities, such as effective assessment of those efforts, are relevant across all disciplines within STEM.

We know that there are a lot of very good programs offered by knowledgeable and talented STEM professionals and volunteers throughout the country. Anecdotally and through research on specific program activities, we know that engineering outreach programs have a tremendous impact on the goal expressed by NSF, as well as by other engineering and science industrial and academic leaders, to broaden the participation of girls and young women in engineering and technology.[7] These large-scale programs are the exception and not the rule, both in terms of funding and effort level, and in terms of their means to analyze and assess effectiveness. Such efforts are well funded, well staffed and resource intensive—and not easily replicated by the people and organizations that normally do STEM outreach. The findings of these exemplary programs are important, and can inform future program development and answer questions about longitudinal retention rates, but they are not designed for export and use by individual STEM practitioners at the program level. What we need to know is how effective are the broad offerings of STEM educational practice and programming at work in K–12 schools, colleges, and community and professional organizations across the country.

When I re-established the Women in Engineering Program at Penn State, one of the first things I did was talk to several directors of similar programs throughout the country and survey the literature to find out what other programs were doing and what the most effective strategies were. What I found was a very dedicated, energetic community rich with people who ran a variety of innovative programs, often on shoestring budgets and with lean staffs and student volunteers. I also found an environment poor in meaningful assessment. And the assessments that did exist took the form of what we call "happy face," or an assessment that asks participants how much fun they had, and includes many engaging quotes from girls and women.

I then sought out literature relevant to my program goals: recruiting women into engineering and developing their talents. Developing hands-on skills, supporting a sense of self-efficacy in engineering, and having active mentors are all well researched as ways to motivate women to succeed. I integrated all three into a three-day orientation program, the Women in Engineering Program Orientation (WEPO), that continues to yield the highest retention rate of any group in the Penn State College of Engineering and was recognized with the PAESMEM award.

The next step was creating effective assessment tools so that I could find out things like how well participants were retained. At that point, I teamed up with Rose Marra, now associate professor of learning technologies at the University of

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[4] Sonnert, Gerhard; Fox, Mary Frank; Adkins, Kristen. (2007). "Undergraduate Women in Science and Engineering: Effects of Faculty, Fields, and Institutions over Time." *Social Science Quarterly*. Vol. 88 (5), pp. 1333–57.

[5] National Research Council Committee on Women in Science, Engineering, and Medicine. (2009). Pre-publication Copy of *Gender Differences in Critical Transition Points in the Careers of Science, Engineering, and Mathematics Faculty*. Washington, DC: National Academies Press.

[6] College Board. (2009). AP Data 2008. Available at: *http://professionals.collegeboard.com/data-reports-research/ap/data*

[7] National Science Foundation. (2003). New Formulas for America's Workforce: Girls in Science and Engineering. NSF 03-207. Available at: *http://www.nsf.gov/pubs/2003/nsf03207/start.htm*; Goodman, I.F.; Cunningham, C.M.; Lachapelle, C.; Thompson, M.; Bittinger, K.; Brennan, R.T.; Delci, M. (2002). *Final Report of Women's Experiences in College Engineering (WECE) Project*. Cambridge, MA: Goodman Research Group Inc. Available online at *www.grginc.com*

Missouri and Co-Founder and Co-Director of the AWE Project, to develop an assessment plan. The step after that was the realization that the need for help in creating good assessment was universal.

We integrated these two key concepts—effective assessment and integration of research findings into programming—when we conceived of the Assessing Women and Men in Engineering Project, or the AWE Project, to develop universal tools that could be used by STEM educational and outreach programs to measure the success of different activities and approaches, compare them with other programs, and continuously improve programs and activities. The more than fifty surveys offered by SWE AWE have been tested and proven effective for both male and female students, and help us to confirm that our efforts on behalf of women are also benefiting men.

AWE moved into the Society of Women Engineers (SWE) to broaden the scope and audience, and to sustain the project and its many products and services. Founded in 1950, SWE is a 20,000 member not-for-profit educational and service organization that empowers women to succeed and advance in the field of engineering. These activities are supported by the NSF Research in Gender in Science and Engineering (GSE) Program.[8] NSF and the GSE Program are leaders in promoting better assessment in their sponsored programs. GSE encourages other grantees to access SWE AWE products, supporting further development and dissemination. To date, the SWE AWE Project has 1065 registered users from 418 institutions and organizations.

The SWE AWE Project addresses the barriers to improving assessment and developing better metrics by looking at assessment as an organizing tool rather than as something tacked on to the end of an activity. It advocates assessment as a method to guide the development and implementation of STEM programs as well as the measurement of outcomes.

The SWE AWE Project is designed to address the core issues that inhibit the development and implementation of effective STEM programming—issues that I faced when I started Penn State's Program—particularly limited resources and a lack of will to assess or reward for assessing.

STEM initiatives typically run with small staffs or volunteers, who often have little assessment expertise, and function on soft money budgets with limited facilities.[9] The staff more often has expertise in developing and implementing programs, advising and outreach, rather than in assessment.

Programs offered by volunteers in companies or through professional societies face similar resourcing issues, with the added problem—and, it has to be stressed, *the added benefit*—that the volunteers are typically experts in STEM fields rather than in education or outreach. These professional volunteers create good programs. They can assess the success of their program with attendance figures and the results of "happy face" surveys. But good assessment and evaluation of those programs—the kind of assessment that leads to sustainable impacts—require assessment expertise, funding and other resources.

The SWE AWE Project promotes effective assessment and evaluation in two ways: 1) by providing exportable survey instruments at the pre-college and college levels that can be adapted and used by programs throughout the country; and 2) by creating capacity for assessment and evaluation among practitioners through the distillation of relevant research findings in Applying Research to Practice (ARP) papers and capacity-building workshops throughout the country. The surveys, which are available in paper and online versions, measure typical objectives for precollege and college level activities and, at the precollege level, are available in science, computer and math versions as well as engineering. ARP resources are developed in collaboration with the National Academy of Engineering Center for the Advancement of Scholarship in Engineering Education. I am submitting a list of the current available AWE Products for the hearing record.

The second issue that the SWE AWE project is designed to address is the will to undertake and use assessment. Offering programs to girls and young women is fun, and their positive responses are rewarding. Assessment, on the other hand, takes time and is designed to tell us what to do better. If resources are limited and everyone is happy with the status quo, why change? Where are the rewards?

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[8] National Science Foundation. (2009). Research in Gender in Science and Engineering Program. Available at: *http://www.nsf.gov/funding/pgm—summ.jsp?pims—id=5475&org=NSF&sel—org=NSF&from=fund*. Award #0120642; #0607081; #0734072.

[9] Goodman, I.F.; Cunningham, C.M.; Lachapelle, C.; Thompson, M.; Bittinger, K.; Brennan, R.T.; Delci, M. (2002). *Final Report of Women's Experiences in College Engineering (WECE) Project*. Cambridge, MA: Goodman Research Group Inc. Available online at *www.grginc.com*; Bogue, B., & Marra, R. (2001). "Informal Survey of WIE Directors." Penn State University.

But lack of effective assessment precludes continuous improvement of activities. How many activities are there out there that have been offered year after year without change—they worked once, but do they still today? Have they taken advantage of new research findings or changing demographics? When I started the women in engineering orientation at Penn State, most of the girls had no experience with e-mail! One of our most popular skill building sessions was learning to use e-mail. That clearly had to change. Today, we offer sessions on how to manage labs and set up computer hardware networks.

Without effective assessment and evaluation, programs can actually be counterproductive. How many activities and events out there are doing the job of committing girls and women to technical careers? How many girls and women are we unintentionally discouraging by not improving our activities using assessment results and new research findings?

This is where funders have a role to play. The Federal Government as a funder should require effective assessment of activities aimed toward NSF's goal of "broadening participation," which is a standard feature of many grant rewards. And federal Title IX reviews, like those conducted by the National Aeronautics and Space Administration (NASA), can be an effective tool for understanding the activities, such as student recruitment and retention programs, that would benefit from an assessment of effectiveness.[10] It is not enough to do "something"—that something should be proven effective, especially where federal funds are used. Industry and professional societies as funders have a similar stake in understanding the effectiveness of funded programs. By requiring annual assessment and evaluation reports, and by basing further funding on how those assessments and evaluations are used to improve programs, effective programs are rewarded; ineffective programs are motivated to improve.

Services like the SWE AWE Project offer ready-made tools that funders and practitioners alike can use to identify and achieve common goals. Greater use of uniform tools also opens the door for comparison of data from a broad variety of programs and venues—which ultimately will allow us a much clearer picture of what works and what doesn't.

There are many ways in addition to the use of good assessment that we can break down the barriers to effective recruitment and development of women in STEM.[11] I will focus on three:

- The application of research to practice,
- Improved learning environments, and
- Sustained and targeted funding.

First, the need for the application of research to practice is essential if we are to develop effective programming for women in STEM. Basic research through programs like NSF GSE is a critical tool for increasing the numbers of women in engineering. Research into why women and girls leave or stay, how psychological constructs can impact decision-making or retention, and understanding the experience of minorities in majority-built and -maintained environments can make or break our combined national effort to increase the numbers of under-represented populations in engineering and other STEM disciplines.

Next, climate studies that look at students' learning and working environment are an important area of research for uncovering barriers for women in engineering. A student's learning environment, or "climate," can have an impact on the successful retention and development of all students in STEM fields. Unwelcoming classrooms, outdated teaching styles, and a lack of accommodation for different social or cultural experiences can all add up to create an environment that students decide to leave rather than thrive in. This affects all students, men as well as women. However, students who are already marginalized as "non typical," or who are severely underrepresented, as are women in engineering, experience these adverse environments more keenly. Much research shares common findings that women who are equally prepared academically as men when they enter engineering leave engineering or science with higher GPAs than their male counterparts who leave, having found less of a sense of community and citing that they have encountered poor teaching. Surveys of students leaving engineering or science, including surveys developed and im-

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[10] National Aeronautics and Space Administration. (2009). NASA Title IX Compliance Program. Available at: *http://www.hq.nasa.gov/office/codee/compliance_program.html*

[11] National Science Foundation. (2003). New Formulas for America's Workforce: Girls in Science and Engineering. NSF 03-207. Available at: *http://www.nsf.gov/pubs/2003/nsf03207/start.htm*; Sevo, R. (2009). "10 x 10 List." Available at *http://momox.org/10x10.html*

plemented by SWE AWE, find that students who leave are less involved in discipline-related activities and fail to develop a sense of community.[12]

AWE results and other findings belie the postulation that women do not pursue engineering because they are just not interested or don't have the talent. Rather, they indicate that women who have the talent and interest are being turned off by how the discipline is presented. Women's high school preparation and GPAs once in college are comparable to men's. In fact, in our recent research females show significantly higher intentions to persist in engineering than their male counterparts.[13] These results show that we don't need to fix the women; we need to fix environments in which they fail to thrive.

Finally, sustained and targeted funding is necessary in order to increase the numbers of women entering and succeeding in engineering: funding for basic research, funding for designing and implementing programs, and funding to support individuals. Such funding has the potential to effect change when it comes with prudent conditions designed to reinforce real change in how programs are developed and evaluated. Funding that includes requirements for effective assessment plans and reports on outcomes that describe how assessment results are used. Funding that requires that basic researchers work directly with STEM practitioners to integrate findings into practice. Funding that provides individual funding to support women students who commit to the completion of studies in STEM fields in which they are under-represented.

There is historical evidence that directed individual funding works. We saw a tremendous change in the number of men who decided to study engineering in the wake of the ground-breaking *National Defense Education Act* (NDEA), which occurred in the wake of the launch of Sputnik in 1958. Today, we see more modest efforts aimed at women in engineering through, for example, the NSF ADVANCE Program, which offers institutional transformation grants aimed at the goal of increasing women faculty in STEM.[14]

Directing that all federal funding in STEM fields must address these issues as a part of any funded project would validate the importance of a creating an inclusive work and study environment and encourage more girls and women to enter engineering.

In conclusion, increasing the number of women pursuing engineering degrees and succeeding in professional careers is an essential component of our ability as a nation to solve the problems we face and to remain a world leader in science and technology. Promoting the use of assessments, like those offered by the SWE AWE Project, and supporting programs at the undergraduate level to overcome barriers to recruit and retain female undergraduates in STEM should be part of the equation. Therefore, we would like to recommend the following policy recommendations to you:

- Sustain and target funding for programs and activities that focus on attracting and retaining women and girls to non-traditional and STEM careers and removing institutional barriers to their success, for basic research related to that goal, and for efforts directed at encouraging individual women to undertake and complete engineering degrees.
- Review federal funding requirements and set guidelines to ensure that funded programs address national priorities and attract a diverse population. Include

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[12] Seymour, E. & Hewitt, N. (1997). *Talking about Leaving: Why Undergraduates leave the Sciences.* Boulder, Colorado: Westview Press; Goodman, I.F.; Cunningham, C.M.; Lachapelle, C.; Thompson, M.; Bittinger, K.; Brennan, R.T.; Delci, M. (2002). *Final Report of Women's Experiences in College Engineering (WECE) Project.* Cambridge, MA: Goodman Research Group Inc. Available online at *www.grginc.com*; Hartman, H. and Hartman, M. (2006). "Leaving Engineering: Lessons from Rowan University's College of Engineering." *Journal of Engineering Education,* Vol. 95, pp. 49–61; Marra, R.; Bogue, B. (2008). "Engineering Classroom Environments: Examining Differences by Gender and Departments." Proceedings of American Society for Engineering Education, June 2008, Pittsburgh, PA; Marra, R.; Rogers, K.A.; Shen, D.; & Bogue, B. (2009). "A Multi-Year, Multi-Institution Study of Women Engineering Student Self-Efficacy," *Journal of Engineering Education,* Vol. 98, pp. 1–12.

[13] Bogue, B. and Marra, R. (2009). "The AWE Family of Projects: Assessing STEM Educational Outreach, Retention Programs and Research on Engineering Undergraduates." Poster presented at the National Science Foundation Joint Annual Meeting, June 2009; Marra, R.; Bogue, B. (2008). "Engineering Classroom Environments: Examining Differences by Gender and Departments." Proceedings of American Society for Engineering Education, June 2008, Pittsburgh, PA.

[14] National Science Foundation. (2009). ADVANCE: Increasing the Participation and Advancement of Women in Academic Science and Engineering Careers (ADVANCE). Available at: *http://www.nsf.gov/funding/pgm_summ.jsp?pims_id=5383*. Also, see ADVANCE portal at *http://www.portal.advance.vt.edu/*

requirements for effective assessment, including reporting of how findings will be used to continuously improve processes.

- Support the continuation of federal Title IX reviews, like those conducted by NASA, as one component of understanding the issues that inhibit the full participation of women in engineering and other STEM disciplines at the college level.
- Provide support for women who wish to pursue engineering degrees. Reward the institutions that make successful efforts to increase the percentages of women studying STEM disciplines in which they are currently under-represented.

Forty years ago yesterday, Neil Armstrong became the first human to set foot on the Moon, thanks to our Federal Government's commitment to set forth a clear vision for achieving that goal by the end of the 1960s. Not only did we have the national will to achieve that event, we supported it financially by ensuring an innovative and productive engineering workforce through the *National Defense Education Act*. Earlier this year, in a speech to the National Academy of Science, President Obama set out an equally ambitious goal to increase research and development funding to levels that exceed those in the era of the space race. To achieve the goal of full participation of women and other under-represented groups in this new bold endeavor will require an equivalently bold commitment. We at the Society of Women Engineers look forward to and support your efforts in this regard.

Thank you again for the opportunity to present our views.

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BIOGRAPHY FOR BARBARA BOGUE

Barbara Bogue is Co-Founder and Co-Director of the SWE AWE (Society of Women Engineers' Assessing Women and Men in Engineering) Project and associate professor of Engineering Science and Mechanics and Women in Engineering and Women in Engineering at Penn State. The SWE AWE Project develops and disseminates assessment instruments for educational outreach, engineering self-efficacy, classroom climate and assessment capacity building tools.

Prior to her current position, Bogue served as Director of the Penn State Women in Engineering Program, hired with the charge to re-institute and revitalize the program. In that role, she created and implemented recruitment and retention programs and was recognized for her achievements with several awards, including the White House Presidential Award for Excellence in Science, Mathematics and Engineering Mentoring (PAESMEM), the WEPAN Women in Engineering and Science Program Award and the Penn State Outstanding Recruitment and Retention Award. A fulfilling part of her career has been the mentoring of young women and men and she takes great pleasure in maintaining contact with Penn State engineers throughout the world. Her activities in this area were recognized with the Penn State Rosemary Shearer Mentoring Award.

Bogue's research focuses on the application of research to practice, assessment, and the development and progression of girls and women in engineering. She is the Principal Investigator of a National Science Foundation grant that moved the AWE Project into the Society of Women Engineers, where it will continue to offer quality products and capacity building. SWE's ownership of the AWE Project ensures continuity and the ability to reach a larger audience. The author of numerous publications, Bogue has developed and presents workshops on assessment, evaluation and faculty development for the Women in Engineering ProActive Network (WEPAN), the American Society of Engineering Educators, the Society of Women Engineers, The Big Ten CIC Faculty Development Workshop, and the National Girls Collaborative Project (webcast). Bogue also evaluates interventions that aim to increase the participation and progression of women and minorities in engineering. The National Science Foundation, the GE Fund, the Henry Luce Foundation, the Engineering Information Foundation, The Engineering Foundation and a variety of corporations have funded her work.

Chairman LIPINSKI. Thank you, Ms. Bogue. And finally, the Chair recognizes Ms. Thomas.

STATEMENT OF MS. CHERRYL T. THOMAS, PRESIDENT AND FOUNDER, ARDMORE ASSOCIATES, LLC

Ms. THOMAS. Good morning, Mr. Chairman, Ranking Member Ehlers, distinguished Members of Congress and this subcommittee.

I am both humbled and pleased that I have been asked to testify before you today.

Rather than a direct academic pursuit of engineering, I came to the field by quite a circuitous route. Actually, I really did not know anyone personally who was an engineer. However, through the encouragement and development of my scientific and mathematical aptitude, and the forward thinking of leaders in my life, my mother, teachers, and mentors, I came to the STEM fields. I hope that you can bear with me for a few moments, while I give you a brief synopsis of my career path.

My earliest recollection of building materials was a Christmas morning, when I spied a very large box of Tinkertoys. These were for my oldest brother. He admonished me not to put my sticky paws on his Tinkertoys. They were special for him to build things. Of course, I couldn't wait to set the Big Ben alarm clock to get up in the middle of the night and play with that set.

As fortune would intervene, eventually, my brothers got an Erector Set. The Tinkertoys cast aside became mine. The first thing I built was a windmill. All these years later, when I see the wind turbines dotting the landscape in rural areas, I have wondered how many of the engineers who have designed or built wind turbines had their interests sparked in their youth by a simple set of Tinkertoys.

Throughout my academic career, I was always interested in the sciences, and I was encouraged to think about or pursue the biological sciences. In high school, I demonstrated an aptitude for chemistry. My career path was set. I would concentrate on biology and chemistry, and think about medicine or scientific research. I received awards for participating in science fairs all four years of high school. One Saturday a month, I went to the Science Academy in Lincoln Park, and every other Sunday, to the Museum of Science and Industry close to where I lived in Hyde Park.

Armed with this foundation, I went off to university prepared to major in biology and chemistry. I completed my undergraduate studies, and went to work for the Department of Water and Sewers in the city of Chicago as a research chemist. I was quite content in this role. I completed a master's degree while working for the city, and began course work for a doctorate.

The latter was interrupted when I was chosen as the first woman to participate in a program of sending young people, up until this point in time, young male engineers, to work in various units of the Department of Water and Sewers, to cultivate an understanding of how not only the units worked, but how the Department worked in total.

It is very important to note that this decision was made by the Commissioner of the Department. I was assigned to the Chief Engineer in the Commissioner's office. The time period was the early '70s. This was not a simple or easy decision to make. To complicate matters, I was not a degreed engineer. Instead, I was learning on the job. To his credit, and I thank him always, the Chief Engineer convinced me to go back to school and take engineering courses.

That was the end of the biological sciences and the beginning of a new endeavor. I was the first woman to work in the field on a

shutoff crew for the Department of Water. Eventually, I ended up running that crew.

What were the barriers I faced? This was unusual. Women were not supposed to work shifts. There were no facilities for women, and quite frankly, women would interfere with the way men talked and worked. Of course, over a short period of time, their fears and mine were assuaged. We were all there to do a job. In hindsight, what a great opportunity and what a great experience.

I worked many years for the Water Department before going on to work in various other infrastructure departments, which culminated in my overseeing all of the infrastructure departments, when I went to work in Mayor Daley's office as his Deputy Chief of Staff.

In 1994, the Mayor appointed me as Commissioner of the Department of Buildings. I was the first woman to hold this position. In this role, my field experience and practical side of engineering would have to get me through learning and understanding the design side. I do credit the discipline of being involved in the sciences as preparation for this demanding role, and as preparation for successful completion of any daunting task.

The biggest challenges to attracting and retaining women and girls in the STEM fields, I think, are exposure at an early age, encouragement and nurturing of ideas, and the pervasive tendency to promote the sciences as career fields for boys and men, although medicine is the exception to this rule.

The most promising solutions continue to work, as a committee such as this, to study and lend credence to the problem. Funding to add programs with mathematics, chemistry, and physics to primary as well as secondary education. Exposing girls and young women to other women who are pursuing these fields.

In a humble way, I do think drawing attention to women like myself, who have come through the ranks, who have persevered, and who are now Presidents and CEOs of their own engineering firms, helps to promote the value of being smart girls and women with STEM field aptitudes.

In closing, I would like to thank you again for inviting me to testify before you today. I am committed, through various organizations and academic institutions, to promoting not only women and minorities in sciences, but also, to developing interests and skills, and expanding STEM opportunities to people as a whole.

I heard a very disturbing statistic, that only about four percent of our young people in this country seek to have careers in the sciences. Those seeking these careers in other countries are as high as 40 percent. If we do not address this issue, who will build our roads and bridges? It is a question we must answer.

Thank you.

[The prepared statement of Ms. Thomas follows:]

PREPARED STATEMENT OF CHERRYL T. THOMAS

Good morning distinguished Members of Congress, colleagues, and all in attendance. I am both humbled and pleased that I have been asked to testify before you today in such august company as the other witnesses.

Rather than a direct academic pursuit of engineering, I came to the field by quite a circuitous route. Although I always had a curiosity at a very young age of building objects, I really did not know anyone personally who was an engineer. However,

through the encouragement and development of my scientific and mathematical aptitudes, and the forward thinking of the leaders in my life, my mother, teachers and mentors, I became what you now know as a leader in the Science, Technology, Engineering, and Mathematics industry.

I hope you can bear with me while I give you a brief synopsis of my career path.

What influenced your decision to pursue a career in engineering, and what were some of the greatest barriers you faced as a woman in a STEM field?

My earliest recollection of building materials was a Christmas morning when I spied a very large box of Tinker Toys. These were for my oldest brother. He admonished me 'not to put my sticky paws on his Tinker Toys. They were special for him to build things.' Of course, I couldn't wait to set the Big Ben alarm clock to get up in the middle of the night and play with that set. As fortune would intervene, eventually my brothers got an Erector Set. The Tinker Toys cast aside became mine. The first thing I built was a windmill. All these years later when I see the wind turbines doting the landscape in rural areas, I have wondered how many of the engineers, who have designed or built wind turbines, had their interests sparked, in their youth, by a simple set of Tinker Toys.

Throughout my academic career, I was always interested in the sciences and I was encouraged to think about or pursue the biological sciences. In high school, I demonstrated an aptitude for Chemistry. My career path was set: I would concentrate on Biology and Chemistry and think about medicine or scientific research. I received awards for participating in science fairs all four years of high school. One Saturday a month, I went to the Science Academy in Lincoln Park. And every other Sunday to the Museum of Science and Industry, close to where I lived.

Armed with this foundation, I went off to university prepared to major in biology and chemistry.

I completed my undergraduate studies and went to work for the Department of Water and Sewers in the city of Chicago as a Research Chemist. I was quite content in this role. I completed a Master's degree while working for the city; and began course work for a doctorate. The latter was interrupted when I was chosen as the first woman to participate in a program of sending young people (up until this point in time young male engineers) to work in various units of the Department of Water and Sewers to cultivate an understanding of how the Department worked, not as units, but in total. It is very important to note that this decision was made by the Commissioner of the Department. I was assigned to the Chief Engineer in the Commissioner's office. The time period was the early seventies; this was not a simple or easy decision to make. To complicate matters I was not a degreed engineer. Instead, I was learning on the job. To his credit, and I thank him always, the Chief Engineer convinced me to go back to school and to take engineering courses. That was the end of the biological sciences and the beginning of a new endeavor.

I was the first woman to work in the field on a shut-off crew for the Bureau of Water. The barriers I faced were:

1. This was unusual.
2. Women were not supposed to work shifts.
3. There were no facilities for women.

And quite frankly,

4. Women would interfere with the way men talked and worked.

Of course, over a short period of time, their fears and mine were assuaged. We were all there to do a job. In hind sight: what a great experience!

I worked many years for the Water Department before going on to work in various other Infrastructure Departments which culminated in my overseeing all of the Infrastructure Departments when I went to work in Mayor Daley's Office as his Deputy Chief of Staff.

In 1994 the Mayor appointed me as Commissioner of the Department of Buildings. I was the first woman to hold this position. In this role, my field experience and practical side of engineering would have to get me through learning and understanding the design side. I do credit the discipline of being involved in the sciences as preparation for this demanding role, and as preparation for successful completion of any daunting task.

What are the biggest challenges to attracting and retaining young women and girls in STEM fields, and what are the most promising solutions to these challenges?

The biggest challenges to attracting and retaining young women and girls to STEM fields are:

1. Exposure at an early age
2. Encouragement and nurturing of ideas
3. The pervasive tendency to promote the sciences as career fields for boys and men. (Although medicine is the exception to this rule.)

The most promising solutions are:

1. Continuing to work as a committee such as this to study and lend credence to the problem.
2. Funding to add programs of mathematics, chemistry and physics to primary as well as secondary education.
3. Exposing girls and young women to other women who are pursuing these fields.
4. Adding an academic standard to the national curriculum of teachers and counselors that trains them to identify and value STEM aptitudes in girls and young women; and provides them with academic and career path tools to develop STEM aptitudes in those girls and young women.
5. In a humble way I do think drawing attention to women like myself who have come through the ranks, who have persevered and now are Presidents and CEOs of their own engineering firms, helps to promote the value of being smart girls and women with STEM field aptitudes.

In closing, I would like to thank you again for inviting me to testify before you today. I am committed through various organizations and academic institutions to promoting not only women and minorities in the sciences, but also to developing interest and skills and expanding STEM opportunities to people as a whole. I heard a very disturbing statistic: that only about four (4) percent of our young people in this country seek to have careers in the sciences. Those seeking to have careers in the sciences in some other countries are as high as forty (40) percent. If we do not address this issue, who will build our roads and bridges? It is a question that we must answer.

Thank you.

BIOGRAPHY FOR CHERRYL T. THOMAS

Cherryl Thomas is President and Chief Executive Officer of Ardmore Associates, a full-service engineering, land surveying, program, project and construction management firm.

From 1998–2003, she was appointed by President William J. Clinton as Chairman of the United States Railroad Retirement Board. She was responsible for the $18 billion comprehensive retirement, survivor and unemployment/sickness insurance benefit program for the Nation's railroad workers and their families.

Ms. Thomas was appointed Commissioner of Chicago's Department of Buildings by Mayor Richard M. Daley where she served from 1994 to 1998. She was responsible for the operation and management of the Department of Buildings with a $28 million budget, the second largest building department in the country. She interfaced with developers, architects and engineers relative to building code issues. Ms. Thomas oversaw the review of architectural plans prior to permit issuance for new construction, rehabilitation and conservation of approximately 450,000 buildings. This department also conducted examinations and issued licenses and/or certificates for multiple building trade disciplines.

Prior to service as Commissioner of the Department of Buildings, Ms. Thomas served as Deputy Chief of Staff in Chicago's Office of the Mayor from 1991 to 1994. She was responsible for the day-to-day interaction with commissioners of city departments and State and local governmental officials. Her primary focus was on infrastructure departments. She initiated the timeline reporting system for all City departments. She served as Chairperson assisting in the development of the Information Technology Steering Committee including geographic information systems, monitored infrastructure construction projects, and worked with various boards, associations and commissions.

Ms. Thomas' career with the city of Chicago began as an engineer-in-training with the old Department of Public Works. During her career, she held various technical and management positions in the departments of Public Works, Water, Sewers and Aviation.

She has an honorary Doctorate Degree from Boston College, a Master's of Science Degree in Physiology from the University of Illinois and a Bachelor of Science Degree in Chemistry and Biology from Marquette University. Ms. Thomas enhanced her career by taking engineering courses at the Illinois Institute of Technology as a non-degree student.

DISCUSSION

Chairman LIPINSKI. Thank you, Ms. Thomas, and thank all of our witnesses for their testimony. Now, we will move on to the Q&A, and the Chair will begin by recognizing Ms. Fudge for five minutes.

Ms. FUDGE. Thank you very much, Mr. Chairman, and thank all of you for being here today.

We know that research has shown us that certainly, female STEM role models are the best way to encourage young people—young women—to become involved in this area. And no offense, Mr. Leshner, but I just would love for some of the young people in our urban schools, in particular, to see you here today, and to be encouraged by what you have done in your careers. And I thank you for being here. And I thank you for your testimony as well.

The question I have, because I am keenly aware that in our urban schools in particular, which I represent primarily, there are very few role models in our schools, whether they be counselors or science teachers or engineers, and that is the unfortunate part of this. So, my question becomes how do we incorporate, in an informal education way, dealing with the under-represented groups in the STEM fields, and how do we get the young women, especially African-American women, in our communities? And what best practices can we use, that can be transferred from an informal setting to the classroom setting?

Anyone or everyone.

Dr. KROPF. Okay. Well, I agree with you completely about your issue about role models and role models for girls of color. Three quarters of the girls served by Girls Incorporated are girls of color. Our Operation Smart program includes the whole concept of bringing in adult women scientists, engineers, and mathematicians, architects, archaeologists, to work on projects with the girls. It is not just a career day, where a woman comes in and talks about her career, but the girls actually see adult women making mistakes, because making mistakes in science is important. It is how you learn. And they see adult women scientists getting their hands dirty, and they can talk casually with them about what it is like to have a scientific career.

Dr. HANSON. I just recently finished a study on young African-American women in science. It is *"Swimming Against the Tide."* And when I talked to them, surveyed them, they don't see their schools as having good resources. They don't see people as thinking much of them becoming scientists. One of the young girls said "they look at us like we are not supposed to be scientists."

And so, what they want is people who think they can do it. They want more resources in their schools. They can see that their schools have fewer resources, especially science. Their labs are not good labs. They want field trips. They want hands-on labs, and I think we need to figure out a way to redistribute our resources so

that if you are unlucky enough to be going to school in a poorer school district, you shouldn't be punished with poorer science labs.

Ms. FUDGE. Dr. Hanson, if I could just say one thing about your comments, well, two. I think you are right about athletes, not because I was an athlete, but—because I don't know anything about science. I am learning as I sit on this committee every day. But I love the concept of what you said, because it does encourage you, and it makes you believe that there are things you can do.

As well, I want to say that as I leave here, and I am going to be doing that shortly because we have a markup in our Education and Labor Committee, we are going to be talking about exactly what you said. We are going to be finding ways to bring more resources into our schools, especially our urban cores, for labs, for computer technology, for things that we think are going to make young people more able to actually understand, to get excited about what is out there, because they can do hands-on.

So, I thank you as well.

Dr. HANSON. Thank you.

Ms. BOGUE. I would like to add a couple of things to that. One is the intentionality of role modeling. I think the idea of bringing them in informally, not specifically as role models, is an excellent idea. But it is very, very important to assess the process, and look at whether those role models have, in fact, done the work that you want them to do.

It is very possible to have people who look like they are going to be perfect role models to come in, and they end up discouraging the children from going on. So, that is an important thing.

And I think another thing is that when we do bring these people in, it can be informal, but it also has to be very intentional. They have to understand why they are there, and what they should be doing, to make sure that these girls and boys make the connection between them being there and working with them, and what they can do in their lives.

Ms. THOMAS. You are absolutely right. Athletics does help. I was an athlete, and it does help. And you also have to be able to step outside your comfort zone, to be the first woman to go out on the street with a crew. I can't even impress upon you how difficult that was. But the fact is, you have to stay with it. You can't be easily discouraged, and I was armed with the knowledge that I probably knew as much as they did, and once we both became comfortable, it was fine.

I think that we really do have to nurture young girls, to realize that they have ideas, that it is okay. You don't have to be channeled somewhere, and that is kind of what happened to me. I was channeled to think of research rather than the hard sciences, which I went back and took just fine, because I could persevere in those fields. So, I think nurturing and sticking with it is very important.

Ms. FUDGE. Thank you, Mr. Chairman. I yield back.

Chairman LIPINSKI. And Ms. Fudge, I have to say, I am an engineer, and I have been on this committee for these terms, and certainly, I learn more and more every day, too. So, you are not the only one. We all go through that.

The Chair now recognizes Mr. Ehlers.

Mr. EHLERS. Thank you, Mr. Chairman. So many questions and so little time. We all really appreciate your testimony and your comments.

I was struck by several things. Ms. Thomas, you mentioned you didn't know any engineers when you were young and growing up. I think that is a good deal of the problem. A lot of both boys and girls don't get exposure these days.

In the old days, growing up on the farm, the boys got a lot of exposure to mechanical things, chemistry, et cetera. The girls didn't. Today, neither one often does. When I give speeches to societies of engineers and scientists, I ask them, go to their nearest school, go to your kids' school. Talk to the teachers. Ask if you can go in and talk to the class, and just tell them what you do in your work. And perhaps arrange a field trip to your lab or your office, or if you are a civil engineer, take them out on the job. Help them learn how bridges are designed and made.

And I think that is a very important activity. The discouraging part is some of these people who have done that have been turned down by the teachers who say, ''we don't have time for that,'' which is very unfortunate.

I was amused by your comment, Ms. Thomas, that when you joined the crew, it seemed to affect the way men talked. And having served on a construction crew myself in my college years, I can say you probably only improved their language. It is not a pretty picture.

Another comment was made, I think Dr. Kropf said something about girls feel ostracized by others when they study the sciences and math, and particularly when they do well. That is not uncommon, and in fact, I experienced the same thing, even though obviously, I am male.

But I still remember, even at the college level, getting a paper back in class, a test paper, and immediately slapping it on the desk face down, so that my colleagues couldn't see what grade I got. And it is incredible that someone who did well has to be ashamed of what they did, but yet, that is part of what goes on in society at times. It is the way for the less competent to get even with you, I suppose.

But what I do, when I speak in high schools, I make a big deal out of this. And first of all, I am a nerd, and I am proud of it, which shocks them a little bit. They don't believe it until I show them my pocket protector. But then I talk a bit about that. 'Who is the richest man in the world? You all know that. He is a nerd.'

I said, 'I can predict that when you get out of school, that is why choosing the right courses is so important in high school. When you get out of school, and you start looking for a job, your choices are pretty simple. You will either be a nerd, or you are going to work for a nerd. Now, which of those do you want?' And it really sort of wakes them up. You know, they just don't have that much contact with the real world, and it does make them think.

Some of this, I think, applies very well to girls and women as well, just to say, 'Hey, lots of opportunities out there. You may not have heard about them. They may not even appeal to you at this point, but think about it. Just think about it. And what you can do.' I am just delighted with what you have done, and you are liv-

ing examples to a lot of the women and the girls in the schools today, and that has to be multiplied over and over again.

The innate prejudices that we have in society are still there, and there are many types of them. And we have to break through the mold on that. So, I just want to thank you for what you have done. I learned a great deal from your comments here, and I hope we can all work together, continue to illuminate this problem, because illumination is half the battle.

And some of the things we have done, in this committee, about publicizing opportunities for women in science, and the Commission on Women in Science, and some of these things are really beginning to have an impact, but you are the leaders in having this impact, and I thank you for it.

With that, I will yield back.

Chairman LIPINSKI. Thank you, Mr. Ehlers, and we have a Member, not of the Subcommittee, but who has a great interest in this area. So, I welcome Ms. Woolsey to the Subcommittee and I recognize you for five minutes.

Ms. WOOLSEY. Thank you very much, Mr. Chairman, for letting me sit in. I, too, have the higher ed markup, which is very important to women and girls, well, women, particularly, by higher ed and STEM.

And thank you for being here today. And Dr. Leshner, thank you for getting it for women and under-represented groups, and all of you wonderful women, for setting such a good example.

This is an issue that is very important to me. Otherwise, I wouldn't come to a subcommittee I am not a Member of. Believe me. Because we have to get more girls involved in STEM education, to keep them there, not just getting them involved, but keeping them interested throughout school, so that they can turn it into a career.

At the very least, what I say is young women and under-represented minorities don't have to be scientists, engineers, mathematicians, but they have to have the option by the time they get to college. And if they cut themselves off, act disinterested, and don't get involved in the right curriculum to have it available to them, by the time they get to college, it is too late.

So, that is why I sponsored the inclusion of the appropriately named Patsy T. Mink Fellowships in the *Higher Education Reauthorization Act*, that passed by Congress, and was signed into law by President Bush last year. Because the Patsy T. Mink Fellowships provide funding and fellowships to encourage women and minorities to go into the graduate programs where they are underrepresented, like the STEM programs, and then move them into teaching fields. Part of it is having a female or a minority model as your teacher. That is so important.

And beyond that, I have introduced many Congresses in a row, and am preparing to reintroduce a bill I call "Go Girl," which will provide grants to schools to promote STEM education in under-represented minorities from K–12. I have been working on this issue, both for elementary education and for graduate study for many, many years. Because if we don't get more girls and under-represented minorities into the STEM fields, we are going to be sending our jobs overseas.

I mean, first of all, we want these groups to have the advantage that STEM provides them, and we want the advantage, as a nation, of their great brilliance of, like all of you have represented up here. But we don't want to be sending these jobs overseas with the new green industries and green technologies. We are going to sit here, and not have enough brainpower to make this happen, when we know we have it.

So, my question to you, and I know I have talked a long time to be getting answers now, but is, at what point do young women in particular turn away from knowing that they are good in science and math, math particularly, in K–12? And how important is it for their parents and their teachers to step in and encourage them?

Ms. BOGUE. Middle school is a big area that girls come into, and the popularity begins to play in, the attitudes of teachers, the access to facilities. So, what we always encourage girls to do is just kind of be able to go underground, and be able to make sure that they follow their interests, and are comfortable with being a little bit odd. And I think that is where the sports can really come in, too, that they can be proud of this.

I think you also get another big break when the girls are in high school, and are deciding, as you point out, on what kind of curriculum they are going to take. A lot of under-represented minorities, a lot of the students at that point opt out of higher level math. That is very hard to make up at the university level.

Going into the university, you get a lot of students starting out in STEM fields, and they will start to make the decision not to. I was speaking with a colleague today, who was saying that she opted out of engineering because she wanted to study Russia, and the curriculum didn't accommodate that. That is changing, but it needs to change more, because of course, the engineers we need today need to have a broader liberal arts type education.

Ms. WOOLSEY. Right. Dr. Hanson.

Dr. HANSON. I agree. In middle school, girls start moving towards getting status from romantic relationships during that time, even very talented ones. The status comes more from that than from academics.

But I might also say that as early as second grade, these "draw scientists" tests show that even if they are talented in science and math, they are drawing pictures of male scientists.

And just to one of your other points about the science labor force. I think there is a lot of proof now that we need a diverse science labor force for better ideas, better inventions, and better science. And I am so glad that there are people that have shown that we do better science with more diversity in science, because we need this to be competitive.

Ms. WOOLSEY. Thank you very much, Mr. Chairman, for having me here.

Dr. KROPF. Can I just speak to the question about the——

Chairman LIPINSKI. Go ahead, Dr. Kropf.

Ms. WOOLSEY. Thank you, Mr. Chairman.

Dr. KROPF. I just wanted to say that the National Council for Women in IT recently published a report that they conducted with the Girl Scouts, which showed that women are more likely than men to say they entered careers in STEM because of encourage-

ment from a teacher, a family member, or a friend. And we also, at Girls Inc., find parents extremely important. In our recent publication, *''Thinking Smart,''* we have a whole section called ''Smart at Home,'' which we have actually translated into Spanish for our Latino families, that has resources and suggestions about things you can do at home to encourage your children.

Ms. WOOLSEY. Well, thank you very much. Mr. Chairman, could I just say, I mentioned Patsy Mink, our colleague that did so much for us, and was the mother of Title IX. Sports is so important, because young women learn to work as a team. They learn to be the captain. They learn, also, to do their individual best. So, we have gotten started with athletics. We must not let that stop. And now, we need to have education at exactly that level or greater.

So, thank you again.

Chairman LIPINSKI. Thank you, and I will, the Chair will now recognize himself for five minutes.

As I was listening to all this, I certainly had similar experiences. Going through my time in college as an engineer I certainly think that there are a lot of things that could have been better for everybody.

There are broader issues for everyone in the STEM fields. Certainly, I don't think that there was enough, in my education, in terms of really relating what we were doing in the classroom to the real world. There was not enough connection between the classroom and the real world, and with professionals who were out there. So, I certainly understand those, and I think, then, that there is probably a special place for women to be involved, and I thank those who are involved in, for example Ms. Thomas, for being involved in really encouraging and help mentoring, especially women, in these areas.

Some of the things we talked about, especially Dr. Kropf and Ms. Bogue, they had talked about informal science education, and the importance of family. That is a good advertisement here for a hearing we are having in the Subcommittee next week, on a systems approach to STEM ed which includes some of those areas. Because I think informal science education is very important, and also, all of the factors that have an impact on who is going to go into the STEM fields, who is going to not just go into STEM fields, but getting a STEM education, which is not just for those who are going to make that their career. So stay tuned next week for that, for our next hearing on that. I think this plays very well into that.

One question I wanted to ask is, why are there some fields, like physics and computer science, that representation of women is so low, whereas other fields, like 62 percent of biology degrees go to women? I mean, that was the one area I did not want to be involved in whatsoever when I was in school. I remember having to dissect the fetal pig in high school, and that completely turned me off of biology.

I am amazed that 45 percent of math degrees go to women, because that certainly was not what I had seen when I was in school. It seems in some of these fields, that we sort of point to in STEM, there is much greater female participation, while others, there is less. What is causing that? What do we know about it? Who wants to start out? Dr. Leshner.

Dr. LESHNER. Maybe I can add a little bit. I think a large problem, generally, is the absence of highly visible role models. That is, in some fields that have a history of being less than fully friendly to women, the absence of very well-known and very well-respected role models is a problem, and I think that we need to do a better job of highlighting those successful role models.

For example, in astronomy, we have people like Vera Rubin, who is among the most respected scientists in this country, and she has inspired a large number of young women. We just don't seem to give recognition to women in some fields as much as we do in others. The number of role models in the life sciences who are women far exceeds the percentage in most of these other fields, so that one feels as if it is a bit of a self-fulfilling prophecy. And we do know that role models play a very important role, as do teachers.

The fact that a young woman has a female teacher has a far greater influence on her willingness to enter STEM fields than the gender of a young man's teacher. Did that make sense? Was that in English? I meant it to be.

Chairman LIPINSKI. I understood what you meant.

Dr. LESHNER. Good. Thank you. And that is true for under-represented minorities as well.

Chairman LIPINSKI. Ms. Bogue.

Ms. BOGUE. Well, I guess my first response is we wish we knew, because then we could do more about it. And there is a lot of research in this area, and certainly, the role model is very important. The critical mass is very important. We were tossing around the 18 percent number for women who graduated in engineering. If you look at electrical engineering or mechanical engineering, we are down to the 11 and 12 percent, which means that women can go through undergraduate programs, and literally never see another woman in her class, or never, importantly, have a woman professor at the head of the class.

And so, this is an important thing, that they don't find about it. But then, I think the more important thing is climate. We go back to the climate issue. These are male professions. They have been developed by males, and so, there is pretty much generally a male environment in those. And unless there is some intervention that makes it comfortable for people who aren't male, who aren't white male, to come into those environments, it is hard for women to penetrate it.

And we hear this all the time. It is not anecdotal. We see it in research, and the way that women respond in their decisions, and why they go into particular disciplines.

And finally, I think it is very important to look at how they are recruited into these, what they see when they look at it. The recent National Academies report *"Changing the Conversation"* touched on this. There is a lot of things that are controversial about that report, but it is really important to remember that when we talk about mechanical engineering, we shouldn't just talk about motors. We should talk about all of the other things that mechanical engineering does.

And then, we note that medical is the one exception to where girls are encouraged to go on, to become doctors now and nurses and nurse practitioners, that they are encouraged to go ahead. And

you see, in some of the engineering disciplines that have larger proportions of women, chemical engineering, bioengineering, environmental engineering, have that kind of component. I think we see some beneficial bleed-off from girls understanding that they can be interested in these areas.

Chairman LIPINSKI. Dr. Hanson.

Dr. HANSON. Thank you. Cherryl touched on the issue of toys. I don't think we can stress toys and games enough. Computer science is something that boys have such an advantage in, because they do play computer games so much more than young girls do. They just feel that they are naturally suited to it.

So, I think the issues of toys and games and parents is also very important. Thank you.

Chairman LIPINSKI. Ms. Thomas.

Ms. THOMAS. I think that it is quite interesting, and I certainly don't know the psychology of it, but it seems to be that if you are interested in the sciences or in math or physics, that for some reason, for young women, it is a natural track to go into medicine. And certainly, we need good doctors, and biomechanical engineering is becoming a field that is huge, and a lot of women now feel it is comfortable for them to go into that. As I said, I think you have to step outside your comfort zone. And I neglected to mention, as well, that when I was a young person, toys are important, but I did get many medical kits. You know, those were given to me, and I could play doctor and operate on my doll, and that was the last time I got a doll, when I operated on the doll, and you know, you take all the candy little pills, and all that sort of thing, and it is okay, and it is fine for you to play with those sorts of things.

So, I think that there has to be somewhat of a psychological and an attitude change, and that it's okay if girls want to play with Erector Sets, and if they want to go into engineering. I took physics, and certainly enjoyed it, but it was just one of those core sorts of courses I was taking to pursue medical research.

Chairman LIPINSKI. Thank you. I have run way over my time here. Now, we will go to a second round of questions, and the Chair will recognize Mr. Ehlers.

Mr. EHLERS. Thank you, Mr. Chairman, and I will try to be brief, because I am also supposed to be at the Education and Labor Committee meeting. I decided this was more important.

Just for interest, my assistant LA here, she has, after reading your testimony, got this idea and to her colleagues on the staff, she asked them to draw pictures, and that they were all male except one.

STAFF. Three women scientists. The rest were all male.

Mr. EHLERS. Three women scientists. The rest were all male. So, the problem goes on and on and on.

Role models, and there has been some discussion on that. It is a very tricky business, and I have been fascinated by that over the years, even in my own experience with my family. I am a scientist, nuclear physicist, and I deliberately did not try to encourage any of my children to go on to math and science. I did, however, almost require them to take some math and science, so they would know what it is, and so they would make an intelligent decision about whether or not they wanted it.

And so, one of my sons is an engineer and just loves it. My daughters make heavy use of their technical knowledge, but they are not in technical fields. It is just very useful to them, and they have advanced because of that. My youngest son, who informed me at a very early age, that he was never going to study math, and he was never going to be a scientist, and was vehement about it, and hated math in high school and so forth, and just rebelled all the way through, and today is a professor of geophysics. The point is, simply, you never know what is going to happen that is going to affect their lives.

My last question and comment. Dr. Hanson, you mentioned that several countries: New Zealand, Iceland, Finland, Albania, and Thailand, have made great progress in creating gender equity. How did they do this? Was this intentional, or is it cultural within their culture, or did they find some magic way to do this?

Dr. HANSON. I think it is some of both. If you look at all equity issues on gender in those countries, they tend to be ahead, not just women in science. I think part of it is equity in the larger education system, with the socialized education and medicine. The problem that we were talking about earlier, with unequal access to good education, doesn't happen to the same extent there.

The climate of gender is different in those countries. Women are a larger number of scientists, larger number of professionals. Women don't see being a professional as being in conflict with being a mother, a family member. This is a big problem for keeping girls out of science. They think they have to be married to science, can't be married to anybody else.

So, as you get into gender climates where people don't believe that any more, in some of these countries, they pay people to stay home and be with their kids. So you can have status and access from being both in these countries.

So, I think when we make better education, and have more equitable gender climates, we will also improve science. Although they have been working, in particular on smaller classes, more accessibility, better trained teachers. But I think it is the larger issue that is as important.

Thank you.

Mr. EHLERS. Any other comments on that? Ms. Bogue.

Ms. BOGUE. Yeah, I think, and I appreciate your comments. My husband was also a mechanical engineer, and our daughter spent a lot of time telling us she would never go into engineering, and if she did, she would never go into mechanical. Well, she is a mechanical engineer, so they can't get past us sometimes.

But I think that with role models, it is very, very important to understand that there are very negative role models out there, too. That if you have people in science and engineering and mathematics who are demonstrating to people that there is no life outside of those fields, or who are representing it in that way, then that really is a big discouragement factor for students.

Or, as I mentioned earlier, if you set up your curricula so that there isn't room to go and pursue your music, or pursue other interests, that is a clear message to students that they shouldn't go on to study this, because they would have to give up too many other parts of your lives.

But I think that, going back to the role modeling again, that it is extremely important. But they do have to remember that there are negative role models and address that. And to make these changes, there has to be real intentionality. It has to be something like what we see with Girls Inc., where they are really working with those kids, and what is remarkable about that organization is, it is not just one camp or one time, they keep going back to the students, and reinforcing what is important and what they can do, what is valuable in getting those people out in front of them.

Mr. EHLERS. Ms. Thomas.

Ms. THOMAS. Role models are extremely important. I spent a lot of time in my youth around people who were involved in the sciences, and my brother majored in physics, so I knew a lot of people when I was very young, who were involved in the sciences.

But if I could take just a second to say one thing. How people react to a situation is very important as well. When I first went downtown as part of the engineering program, to introduce people who were going to work for the city of Chicago, and to different disciplines in the Water Department, the reason I went was the Chief Filtration Engineer, whom I worked for, he had daughters, and he believed that girls should not be working shifts, or be in a plant with men and whatever. And I was up for a promotion, and the only way to promote me was to put me out into the filtration, as a control chemist, and he didn't want to do that.

The person I went downtown to work for, who was the Chief Engineer for the entire Department, also only had girls, but he thought that girls should have all the advantages that boys had, and he was the one that convinced me to go back to school for engineering. So, you have two people who have a situation, and one looks at it one way, and the other one looks at it another way. And I think that is really important, too, is how somebody reacts to a situation that they are given.

Mr. EHLERS. Well, thank you very much. It is enlightening, and I really appreciate all of your testimony.

Speaking of jobs where you really have no life outside of the job, try becoming a Member of Congress sometime. With that, I yield back.

Chairman LIPINSKI. And it is hard to disagree with that one. Thank you, Dr. Ehlers, and one thing that came to mind that I just wanted to mention. My experience, when I was in college, I wasn't in SWE, but my friends who were in SWE seemed to really find it very helpful. And I think the importance of having support groups, also, I think that is something that is critical. Whether you are in college or wherever it is, support groups of people who are doing similar things as what you are doing, is also something that can be helpful. And I think SWE certainly serves that role for a lot of women who are engineering majors.

Well, with that, before I close, I want to thank all the witnesses for being here today and for testifying before the Committee. Obviously, this is something that is not going to go away. There is progress that has been made, obviously, and we have talked about that, but certainly, more has to be done. And I think that this has to be considered, not just an issue for women, but for our country, as we struggle with trying to get more people into STEM education

and into the STEM fields. It is critical for the future of our country. So, I thank you, all of you, for the work that you are doing on this.

So, for the official statement here, the record will remain open for additional statements from Members, and for answers to any followup questions the Committee may ask the witnesses.

And with that, the witnesses are excused, and the hearing is now adjourned.

[Whereupon, at 11:30 a.m., the Subcommittee was adjourned.]

Appendix:

Additional Material for the Record

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STATEMENT OF THE AMERICAN ASSOCIATION OF UNIVERSITY WOMEN

Subcommittee Chairman Lipinski, Ranking Member Ehlers, and Members of the Committee, thank you for the opportunity to submit a statement for the hearing *"Encouraging the Participation of Female Students in STEM Fields."*

The American Association of University Women is a membership organization founded in 1881 with approximately 100,000 members and 1,300 branches nationwide. AAUW has a proud 127-year history of breaking through barriers for women and girls. Today, AAUW continues its mission through education, research, and advocacy. AAUW supports promoting and strengthening science, technology, engineering, and mathematics (STEM) education, especially for girls and other under-represented populations. These efforts will help increase America's competitiveness by reducing gender barriers that deter women from pursuing academic and career goals in STEM fields.

Early Barriers and Inconsistent Scoring

Girls' participation rates in STEM courses have unquestionably increased since the passage of Title IX. Before Title IX, many opportunities to advance STEM skills were denied to women, inside and outside of the classroom, including opportunities to participate in higher-level courses and math and science clubs.[1] However, barriers to girls' and women's progress in STEM are still present and begin in K–12 education, starting with the messages received in the schools themselves. In a 2006 Girls Inc. survey, 44 percent of girls and 38 percent of boys agreed with the statement, "the smartest girls in my school are not popular," and 17 percent of girls and 14 percent of boys thought that it was true that "teachers think it is not important for girls to be good at math."[2] A report of the Commission on the Advancement of Women and Minorities in Science, Engineering and Technology says that there are four points in life at which girls and women seem to lose interest in STEM: as they enter middle school, late high school, college and graduate school, and in their professional lives.[3] According to a 2005 report by the National Center for Women and Information Technology, when high school girls think of computer scientists, they think of geeks, pocket protectors, isolated cubicles and a lifetime of staring into a screen writing computer code.[4] These pervasive attitudes and messages influence girls' academic paths early, and future options in STEM may be curtailed for girls because they have insufficient course foundations.

According to the National Assessment of Educational Progress (NAEP) 2005 High School Transcript Study, the largest gap between boys' and girls' scores on math and science assessments in grades four, eight, and twelve was a mere four points, and girls' high school math grades were higher than boys'. However, despite the fact that on average girls complete more challenging curricula, earn higher GPAs in high school, and in 2008 comprised nearly 60 percent of AP test-takers, among AP physics test-takers, only 31 percent were girls, and girls made up only 17 percent of those taking the AP computer science exam.[5]

Another area of concern is the disparity between girls' grades in high school and college and their scores on the SAT exam. The SAT is designed to predict the performance of a student in his/her first year of college and is regularly used as an admissions factor by colleges. Although girls are achieving higher high school grades in math than boys, the average SAT math scores for 2008 showed that boys were 33 points ahead of girls, and this trend is consistent as far back as 1972.[6,7] Likewise, the Massachusetts Institute of Technology found that a woman with the same

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[1] Roché, Joyce. (June 19, 2007). "U.S. House Committee on Education and Labor Hearing, 110th Congress: Building on the Success of 35 Years of Title IX."

[2] Girls Inc. (October 2006). The Super Girl Dilemma: Girls Feel the Pressure to be Perfect, Accomplished, Thin, and Accommodating. Retrieved December 29, 2008, from *http://www.girlsinc.org/supergirldilemma/*

[3] Congressional Commission on the Advancement of Women and Minorities in Science, Engineering and Technology Development. (2000). Land of Plenty: Diversity as America's Competitive Edge in Science, Engineering and Technology. Retrieved December 29, 2008, from *http://www.nsf.gov/pubs/2000/cawmset0409/cawmset_0409.pdf*

[4] Dean, Cornelia. (April 17, 2006). Computer Science Takes Steps to Bring Women to the Fold. *The New York Times.* Retrieved December 29, 2008, from *http://www.nytimes.com/2007/04/17/science/17comp.html?_r=1&oref=slogin*

[5] *Ibid.*

[6] Corbett, Christianne, Catherine Hill & Andresse St. Rose. (2008). *Where the Girls Are: The Facts About Gender Equity in Education.* American Association of University Women. Washington, D.C.

[7] College Board. (2008). 2008 College-Bound Seniors: Total Group Profile Report. Retrieved June 29, 2009, from *http://professionals.collegeboard.com/profdownload/Total_Group_Report.pdf*

SAT score as a man was likely to get better grades. After adjusting its admissions process to compensate for the SAT's "under-prediction," MIT has found that its women students earn higher GPAs in more than half of majors even though their average SAT-math score is 20–25 points lower than that of their male peers.[8]

Slow Progress in College

Women now make up a majority of college students. In 2006–2007, 57 percent of undergraduate degree recipients were women, up from 42 percent in 1970.[9] Despite this incredible growth, women earned only 23 percent of all Bachelor's degrees granted in engineering and engineering technologies in 2006, and a decreasing share of Bachelor's degrees in mathematics and computer science.[10] According to the National Science Foundation, the number of mathematics and computer science degrees earned by women peaked in 1985 at 39.5 percent of total mathematics and computer science degrees granted.[11] By 2006, this number had decreased to only 26.8 percent of mathematics and computer science degrees granted.[12] Between 2000 and 2008, there was a 79 percent decline in the number of incoming undergraduate women interested in majoring in computer science.[13]

The need for STEM legislation is greatest for female minorities. In 2008, 27 percent of computer scientists were female, while only three percent were female and African-American and one percent was female and Hispanic.[14] With globalization and increased global competitiveness, it is more important than ever that the United States put in place policies that encourage study in STEM fields. Of the college-age population earning science and engineering degrees, the United States currently ranks 17th, down from third place several decades ago.[15]

One way to improve this situation is to address challenges that cause undergraduate women to transfer out of STEM fields before graduating. Unsupportive classroom environments and outdated pedagogy inhibit women's participation in STEM, as do a lack of female role models and a limited peer group.[16] After college, women scientists and engineers earn less and advance more slowly than men in both academia and the private sector. This can, in turn, deter all but the most persistent women from choosing and staying on these paths. For example, research by the Society of Women Engineers recently found that 25 percent of women who had earned college degrees in engineering were not working in engineering or a related field compared to 10 percent of men.[17]

Improving Girls' and Women's Opportunities in STEM

In order to improve upon recent gains in STEM education and provide much-needed opportunities to girls and women, programs must be developed that encourage girls and women to pursue STEM studies and careers. AAUW supports the following efforts to improve girls' achievement in math and science and increase the number of women who choose careers in STEM fields.

Improve Teacher Training: AAUW supports efforts that train teachers to encourage girls and other under-represented groups to pursue math and science careers. Teachers need to be trained on how to be sensitive to gender differences when

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[8] Sullivan, Morgen. *Sex Bias and the Scholastic Aptitude Test.* Retrieved December 29, 2008, from *http://www.dartmouth.edu/?chance/course/student_projects/morgen/node1.html*

[9] U.S. Department of Education, National Center for Education Statistics. (2009). The Condition of Education 2009 (NCES 2009–081). Retrieved June 29, 2009, from *http://nces.ed.gov/pubs2009/2009081.pdf*

[10] National Science Foundation, Division of Science Resources Statistics. (2009). Women, Minorities, and Persons with Disabilities in Science and Engineering: 2009, NSF 09–305. Retrieved July 17, 2009, from *http://www.nsf.gov/statistics/wmpd/pdf/nsf09305.pdf*

[11] National Science Foundation, Division of Science Resources Statistics. (October 2008). Science and Engineering Degrees: 1966–2006. (NSF 08-321). Retrieved June 29, 2009, from *http://www.nsf.gov/statistics/nsf08321/pdf/nsf08321.pdf*

[12] *Ibid.*

[13] National Center for Women & Information Technology. (2009). By the Numbers. Retrieved June 29, 2009, from *http://www.ncwit.org/pdf/BytheNumbers09.pdf*

[14] National Center for Women & Information Technology. (2009). By the Numbers. Retrieved June 29, 2009, from *http://www.ncwit.org/pdf/BytheNumbers09.pdf*

[15] Society of Women Engineers. (February 2006). General Position Statement on Science, Technology, Engineering, and Mathematics (STEM) Education and the Need for a U.S. Technologically-Literate Workforce. Retrieved June 29, 2009, from *http://societyofwomen engineers.swe.org/images/stories/SWE_STEM_Education—Statement.pdf*

[16] Fancsali, Cheri. What We Know About Girls, STEM and Afterschool Programs. Retrieved December 29, 2008, from *http://gsg.afterschool.org/images/public/Resources/We_Know_About.pdf*

[17] Society of Women Engineers. (April 26, 2006). Attitudes and Experiences of Engineering Alumni. Harris Interactive Market Research.

teaching all subjects, especially math and science. Teacher training would include ways to engage students in the face of gender-based peer pressure and parental expectations. This is particularly important because while studies show that all students start to lose interest in science and math by junior high, the loss is particularly steep for girls at puberty and likely results from gender-based social expectations and peer pressure.[18]

Encourage the Inclusion of STEM Subjects and Activities in Co-curricular Programs: Incorporating STEM subjects and activities in after-school and summer programs enables students to explore the field in a supportive atmosphere and enhances student interest in STEM careers. Research suggests that information about the usefulness of engineering to everyday human concerns and hands-on experiences with science, math, and technology may help girls develop an interest in these fields.[19]

Emphasize Math and Science in Early Education, Not Just High School: Studies show that students begin to lose interest in STEM subjects by junior high school; this is particularly true for girls.[20] Teaching children about math and science in elementary and middle school is critical to not only improving subject matter competency but also sparking and maintaining girls' interest in the field. AAUW supports voluntary content standards that cover mathematics and science for kindergarten through grade 12 and reflect the knowledge students need to enter college or the workforce and compete in the global economy. The *America COMPETES Act* directs the National Academy of Sciences to convene an expert panel to identify promising practices and critical skills in STEM teaching and learning; their work may be helpful in developing these standards.

Measure Student Achievement in Science: AAUW supports measuring student achievement in science. This will provide schools with necessary information on how well students are progressing and the improvements that still need to be made. The data gathered from such testing programs should always be disaggregated by sex, race and socioeconomic status and cross-tabulated. While testing is an important measure of success, high stakes testing should not be the sole indicator of student competency or a school's progress. Additional flexibility in Adequate Yearly Progress (AYP) measures required by the *No Child Left Behind Act* should be explored.

Ask For a Report Responding to "Rising Above the Gathering Storm": The report, commissioned by Congress from the National Academies on Science, Engineering and Medicine and published in 2007, states that the United States' advantages in science and technology are eroding and discusses the need to improve math and science education. Unfortunately, the report largely ignores the issue of women and under-represented minorities in STEM fields. AAUW recommends that Congress request a more specific follow-up study on methods to increase the number of women in STEM fields and the effect this would have on U.S. leadership in the global marketplace.

Use Title IX to Improve the Climate for Women in STEM Fields: AAUW recommends requiring agencies to broadly and proactively conduct Title IX compliance reviews. Title IX of the Education Amendments of 1972 is the federal statute prohibiting sex discrimination in education programs and activities that receive federal financial assistance. The law states, "No person in the United States shall, on the basis of sex, be excluded from participation in, be denied the benefits of, or be subjected to discrimination under any educational program or activity receiving federal financial assistance."[21] To ensure compliance with the law, Title IX regulations require recipients of federal education funding to evaluate their current policies and practices, and adopt and publish grievance procedures and a policy against sex dis-

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[18] Congressional Commission on the Advancement of Women and Minorities in Science, Engineering and Technology Development. (2000). Land of Plenty Diversity as America's Competitive Edge in Science, Engineering and Technology. Retrieved on December 29, 2008, from *http://www.nsf.gov/pubs/2000/cawmset0409/cawmset_0409.pdf*

[19] Jozefowicz, D.M., B.L. Barber, et al. (1993). Adolescent Work-Related Values and Beliefs: Gender Differences and Relation to Occupational Aspirations. Biennial Meeting of the Society for Research on Child Development. New Orleans, LA: 1–22. And Fancsali, Cheri. What We Know About Girls, STEM and Afterschool Programs. Retrieved December 29, 2008, from *http://gsg.afterschool.org/images/public/Resources/We_Know_About.pdf*

[20] Congressional Commission on the Advancement of Women and Minorities in Science, Engineering and Technology Development. (2000). Land of Plenty Diversity as America's Competitive Edge in Science, Engineering and Technology. Retrieved on December 29, 2008, from *http://www.nsf.gov/pubs/2000/cawmset0409/cawmset_0409.pdf*

[21] Title IX of the Education Amendments of 1972, 20 U.S.C. §1681–1688 (1972). Retrieved January 6, 2009, from *http://www.usdoj.gov/crt/cor/coord/titleixstat.htm*

crimination. Title IX does not require quotas or proportionality. Simply put, Title IX reviews ensure that women are not being discriminated against.

Federal agencies and departments such as NASA, Department of Energy, and Department of Defense should conduct Title IX compliance reviews at grantee institutions regularly. All agencies are required by law to ensure they are not violating Title IX, however very few Title IX reviews are conducted outside of the Department of Education. However, the Department of Energy and NASA have both conducted Title IX reviews at grantee institutions. These Title IX reviews could serve as a model in terms of what factors to consider, how to conduct reviews, and how to improve reviews, when conducting future reviews. The Administration should make it a government-wide priority that agencies use their contracting and grant making authority to ensure that universities that receive agency funding are complying with Title IX. In addition, AAUW strongly supports the idea that colleges form an NCAA-like inter-institutional monitoring organization that shares data, evaluates progress, and uses Title IX and other civil rights laws to eliminate gender bias in STEM fields.

STEM Programs and Activities

AAUW branches run many programs that increase girls' interest and participation in STEM. One example is AAUW California's Tech Trek Science Camp, which is a one-week residential summer scholarship camp for rising eighth graders. Founded in 1998, the camp was designed to encourage young women to continue studying science and math in middle school. So far, over 5,600 girls have participated in the program. Activities at Tech Trek include hands-on projects such as designing and building roller coasters, hot air balloons or rockets, and core classes including astronomy, crime scene investigation, marine biology, mathematics, microbiology, physics, and robotics. The history and achievements of women in math and science is emphasized through courses, skits, guest speakers, and the excellent example of the volunteers and staff of the Tech Trek camp itself.

The camp takes place on college campuses, projects are led by experienced STEM professors and professionals, and AAUW members organize and run the camp. Several years ago, AAUW began surveying participants. They indicated much higher levels of science and math course taking in high school, as well as increased participation in AP science and math sources. They exceed national norms for college attendance, with 96 percent enrolled in college. Fifty-three percent indicated that they were majoring in science and math-oriented fields, a greater percentage than the national average. All participants credited Tech Trek for encouraging their interest in science and math-related careers.[22]

Another STEM program AAUW members run is Tech Savvy in Buffalo, NY. This day-long program for girls in sixth to ninth grade targets minority and lower-income girls and includes workshops on different STEM careers and keynote speakers to inspire girls to consider careers in STEM. The program also includes sessions for parents and teachers since their feeling towards these careers often influences girls' decisions to pursue STEM careers. In four years, the program has grown from approximately 275 students and adults to almost 700 students and adults. Assessments of the program indicate that students expanded their view of the career possibilities not previously imagined as well as the immediate application of concepts from the books and materials provided in the conference.

AAUW is also a key partner in the National Girls Collaborative Project (NGCP), which receives funding from the National Science Foundation. NGCP strengthens the capacity, impact, and sustainability of existing girl-serving STEM programs. The goal of the project is to facilitate collaboration among organizations, institutions, and businesses committed to expanding participation of women in STEM. Regional collaborative teams across the U.S. bring together organizations to compare needs and resources, share information, and strategically plan to expand STEM-related opportunities for girls and women. To date, 14 regional collaboratives have been established to bring together local organizations committed to informing and encouraging girls to pursue STEM careers. These regional teams have appeared on public TV, offered professional development for teachers, and held forums demonstrating best practices to encourage girls to enter STEM fields.

The NGCP, web site *www.ngcproject.org*, offers a wealth of resources to serve a growing nationwide community that supports girl-serving STEM programs. Approximately 1,350 programs across the U.S., representing more than three million girls, are now listed in the NGCP's Program Directory. The site also hosts information

[22] Wolbach, Marie. (Fall/Winter 2007). Strength in Numbers: Sustaining Girls' Interest in Math and Science. AAUW Outlook.

about the more than 84 competitive mini-grants awarded by regional collaboratives for projects such as AAUW North Carolina's pilot program to provide IT training for girls. The web site also provides free access to NGCP-produced webcasts, statistics about STEM education, and proven strategies, curricula, and assessment tools that build the capacity of organizations to provide high-quality learning environments for girls in STEM. Many NGCP projects use the Assessing Women and Men in Engineering (AWE) assessments to evaluate their programs.

Research on Girls and STEM

While a large body of research exists on the involvement of girls and women in STEM fields, most of this research remains inaccessible to many audiences. In early 2010, AAUW will be releasing a report targeted towards a general audience that will highlight key findings from recent academic research on girls and women in STEM. Focusing on top findings, rather than comprehensive overview, the report will focus on topics such as gender differences in interest in STEM fields, gender differences in cognitive abilities, how stereotypes influence girls, and how mentoring can make a difference. Case studies and personal stories will be used to illustrate common themes across STEM disciplines and across stages of educational and work-life progression. Throughout, reasons behind the persistent gender inequity in STEM will be explored.

While the report is still in draft form, early findings show that most differences between boys and girls in terms of math achievement in elementary and high school have disappeared. However, there is a big drop-off in women's participation in science and math at the transition from high school to college. High school girls are as likely as boys to take advanced math and science classes but are much less likely than boys to intend to major in a STEM field once they go to college. College and work environments in certain STEM fields continue to be unwelcoming to women. Mentoring can help women persist in STEM fields in both college and the workplace. AAUW looks forward to sharing the report with the committee once it is completed.

Conclusion

Girls and women continue to face barriers to entering and persisting in STEM fields. At the same time, the supply of new STEM workers is not keeping up with the demand, and women remain severely under-represented.[23] Women make up half of the population and are a largely untapped resource that could prove essential in maintaining the global competitiveness of the United States. With better enforcement of Title IX and increased investment, the United States can begin to close the gender divide in STEM fields. Thank you for the opportunity to submit written testimony.

[23] Society of Women Engineers. (February 2006). *General Position Statement on Science, Technology, Engineering, and Mathematics (STEM) Education and the Need for a U.S. Technologically-Literate Workforce.* Retrieved December 29, 2008, from *http://societyofwomenengineers.swe.org/images/stories/SWE_STEM_Education_Statement.pdf*

STATEMENT OF THE COUNCIL ON UNDERGRADUATE RESEARCH

Today, the Nation faces challenges in its efforts to produce a highly skilled workforce in the science, technology, engineering and mathematics (STEM) disciplines. There are several undeniable imperatives, among them: the need for more young people to fulfill their potential, for more students to study and pursue careers in STEM and for more research-based solutions to the serious scientific, economic and social problems facing the Nation.

Undergraduate research is a proven and powerful way to achieve these goals. Undergraduate research is an inquiry or investigation conducted by an undergraduate student that makes an original intellectual or creative contribution to the discipline. High-quality research and scholarship activities enhance educational outcomes, and encourage young men and women to pursue STEM-related disciplines and contribute to the body of knowledge needed to tackle serious problems.

Another equally important imperative is increasing opportunities for students who have not traditionally been involved in research. The Nation will not be fully prepared to solve our most difficult challenges unless we unleash the full potential of all of our best and brightest students. And that means addressing increased interest and persistence in STEM fields among females.

There are strategies at community colleges, minority-serving institutions, four-year colleges, comprehensive universities, and research universities that successfully expanded opportunities for undergraduate research, especially for students who are not traditionally involved in undergraduate research, including young women. Common to most of these successful programs are practical strategies for building sustainable programs; engagement of a broad range of participants, partners, and stakeholders; integration of programs into the fabric of the institution; advocacy for change and expanding participation; and alignment of departmental and institutional goals.

Today, the country's K–12 schools are largely consumed with the requirements of the *No Child Left Behind Act*. While the law is one with many programs and intentions, its requirements, in the simplest terms, focus on achievement in reading and math. Science teachers lament the resulting lack of flexibility in the curriculum and the absent opportunity to include more science, social studies, arts, and creativity in the offerings. Some argue that the law's goal is to make sure all students meet minimum expectations, resulting in insufficient investments of time and effort in challenging young people to reach their greatest potential. While the law is due for changes via the reauthorization process, the continued focus on math and reading as the basis for any common standards initiative and the sentiment that science is "next" is troubling. Science has been "next" in terms of being included in accountability and assessment rubrics for close to a decade, and any changes to federal law or state adoption of common standards puts real change off for at least another five years. This affects all students, but if young ladies are not exposed to focused instruction in science at the earliest grades, it seems unlikely they will pursue it past secondary school.

Many have investigated the factors affecting girls' interest and participation in STEM learning at the K–12 level. At the grade school level, the teachers are creative, energetic, and overwhelmingly female. They also are often intimidated by math and often science. In their college careers, the majority of prospective elementary school teachers takes only the math and science that is required for graduation and thus, have little background in these areas to bring to their classrooms.

The country needs science majors who choose to teach at the K–12 level and science teachers with real content knowledge. The National Science Foundation's (NSF) Noyce Fellowship Program addresses this very need. In addition, the NSF Course, Curriculum and Laboratory Improvement (CCLI) program invests in delivering strong science content to teachers to be sure they are comfortable learning and teaching the subject. Further, prospective teachers involved in undergraduate research learn the processes of science and impart that to their student when in the classroom. Further, the experience with research creates a familiarity with data to inform practice, as is encouraged in teaching today via the *No Child Left Behind Act*.

Interest in science is something that has to be nurtured early for both females and males and if K–12 teachers are not strongly versed in science, this nurturing will not be as strong as it could or should be. Further, by the time girls get to middle school, there are a number of complex social issues and puberty that detract their interests. At this age it is simply "not cool" to be smart and if one excels in math and science, they are immediately labeled as "geeky." This negative peer pressure is an extremely important issue in terms of attracting girls to STEM fields, but not one easily addressed.

At the post-secondary level, of those females who pursue science, it seems they gravitate to the life sciences (biology, biochemistry, neuroscience, and environmental science) to an extent that is even more skewed than the overall student body proportion of women. In chemistry and math, the numbers are more balanced, but a female physics major is a rarity. Many researchers have investigated this phenomenon, and point to the absence of nurturing environments in academia, or competition among fellow students that leaves young ladies searching for a more collaborative learning environment. Further, some argue the applications of science (physics, engineering, math, chemistry) to solving societal problems, such as clean water, environmental sciences, conservation efforts, of societal poverty, might appeal to female students more than what are considered typical applications. Young women need to learn about these applications, and need to see women in faculty positions at post-secondary institutions of all kinds—community colleges, predominantly undergraduate institutions, research universities—if more of them are to be successful in these areas.

The ADVANCE program of the National Science Foundation is an outstanding example of a vital program that seeks to develop systemic approaches to increase the representation and advancement of women in academic STEM careers. It is essential that this program serve all types of institutions, not just research-intensive universities. Academic women face gender inequities and challenges at all career stages and at all types of institutions, including primarily undergraduate institutions, community colleges, minority-serving institutions, women's colleges, and institutions primarily serving persons with disabilities. Continuing and expanding the federal support for this critical NSF program is essential to enhance the academic culture and institutional structure to support female science and engineering professors who serve as key mentors and role models for female students.

One particular example of an ADVANCE project that aims to enhance the advancement of academic women in science and engineering careers is the NSF–ADVANCE–PAID project HRD–0619150 "Collaborative Research for Horizontal Mentoring Alliances." This project involves women full professors in chemistry and physics at 20 distinct liberal-arts colleges. Through the formation of five-member alliances, these senior women faculty members have tested a "horizontal mentoring strategy" to promote the leadership and visibility of women scientists and engineers on their campuses. The presence of successful and visible women faculty members, particularly at the full professor level, can signal a campus-friendly environment for both female students and faculty. Evidence of the importance of women in academic leadership can be a powerful means of facilitating both the recruitment and retention of women students and faculty and enable them to flourish in science and engineering careers.

A recent tool unveiled by the Business Higher Education Forum suggests that it is the first year of post-secondary study that is the point of highest leverage in the STEM pipeline. Undergraduate research opportunities play a key role in allowing young ladies to "try on" being a scientist. This introduces them to scientific research, but also socializes the students into what a scientist does. The NSF Research Experiences for Undergraduates program is a key program that funds these opportunities.

In 2006 the Committee on Women in Science and Engineering of the National Academies published the report *To Recruit and Advance: Women Students and Faculty in Science and Engineering.* The aim of this publication was to provide a guide to the strategies that have proved successful in recruiting and retaining women undergraduate, graduate, and postdoctoral students in science and engineering and recruiting and advancing women faculty in these fields. The final chapter provides an extensive list of effective strategies for recruiting, retaining, and advancing women at each educational and career stage. Two potential obstacles that are cited as deterring female undergraduates, graduates, and post-doctoral candidates from remaining in science and engineering are lack of role models and curricula perceived as less interesting or less relevant. Three of the important means of retaining women students in science are establishing mentoring programs, increasing engagement of students, and increasing professional socialization. Participation in undergraduate research is specifically discussed as a means of addressing these three objectives.

Indeed, these specific student benefits are noted in the chapter "The Benefits of Undergraduate Research, Scholarship, and Creative Activity" by J.M. Osborn and K.K. Karukstis in *Broadening Participation in Undergraduate Research: Fostering Excellence and Enhancing the Impact* (M.K. Boyd and J.L. Wesemann, eds., Council on Undergraduate Research, Washington, D. C., 2009, Chapter 4). "Indeed, for all students, interactions with faculty members significantly affect an individual student's cognitive and behavioral development and directly impact student satisfaction

and learning (Astin, 1993). Recent results of the National Survey of Student Engagement (Lipka, 2007) corroborate that participation in undergraduate research with a faculty mentor is a "high impact" learning experience. Additional studies verify that the collegial and collaborative partnership of undergraduate students and faculty members contributes significantly to the personal and professional gains reported by students as a result of their research experience (Seymour, 2004; Hunter, 2006)." The benefits with regards to professional growth and advancement are also commonly acknowledged by students pursuing undergraduate research. Some of the key benefits of undergraduate research related specifically to career development include stronger relationships with mentors and other professionals, deeper integration into the culture and profession of the discipline, and enhanced ability to identify and make informed decisions about appropriate career interests. Undergraduate research also promotes many elements of personal growth, including increased confidence and an enhanced development of personal initiative. All of these factors can contribute to retaining women in the STEM disciplines.

As Congress works to address the country's education and workforce needs, which must include maximizing the potential of every young man and woman who does or could have a career in the STEM disciplines ahead of them, the Council On Undergraduate Research will continue to work to expand opportunities to expose young people to undergraduate research that will inform and encourage their academic and professional pursuits. There are a number of federal investments that support the endeavor of undergraduate research, and CUR and its members will work to sustain and grow these investments and educate educators, researchers, scientists, undergraduates, business and others on its importance.

About CUR: The Council on Undergraduate Research (*www.cur.org*) supports faculty development for high-quality undergraduate student-faculty collaborative research and scholarship. Nearly 600 institutions and over 3,000 individuals belong to CUR. CUR believes that the best way to capture student interest and create enthusiasm for a discipline is through research in close collaboration with faculty members.

STATEMENT OF THE GIRL SCOUTS OF THE USA

Despite improvements in educational equity, girls and women continue to lag behind men in terms of mathematic and scientific achievement and advancement toward and attainment of careers in Science, Technology, Engineering and Math (STEM). Girls begin to lose interest in STEM early in their education; the percentage of girls who say they would not study math anymore given the choice increases in 4th, 8th, and 12th grade from nine percent to 15 percent to 50 percent respectively.[1] While girls consistently match or surpass boys' achievements in science and math in scholastic aptitude tests, achievement tests, and classroom grades, high school girls are less likely than boys to take AP physics or computer science exams.[2]

This weak academic pipeline, along with other factors in and out of the classroom, is causing fewer women to pursue careers in STEM fields. According to the National Science Foundation, women represent 46 percent of the total workforce in America, but only 25 percent of the workforce in the fields of science and engineering.[3] This gender gap holds serious consequences—and opportunities—for the future of our country and its girls. Eighty-nine percent of Fortune 1000 STEM executives agree that bringing more women and minorities into STEM fields will help solve U.S. workforce shortages.[4]

GIRL SCOUTS STEM PROGRAMMING

In 1912, Juliette Gordon Low founded the first Girl Scout troop in Savannah, GA. In 1913, the first badges in Science, Technology, Engineering and Math (STEM) fields—the electrician badge and the flyer badge—were introduced. Today, with 2.7 million girl members and 900,000 adult members in every corner of the United States, Puerto Rico, the Virgin Islands and ninety-five countries worldwide, Girl Scouts continues to lead the way in ensuring that girls enjoy a comprehensive, relevant and robust STEM education. Girl Scouts is committed to girls' exploration and pursuit of education and careers in STEM in order to increase the number of girls pursuing careers in STEM-related fields.

Through more than 70 badges and patches in STEM-related activities for Girl Scouts ages 5–17, girls are encouraged to explore the many ways in which STEM fields relate to their lives. Our research-based programs help girls develop an interest in STEM fields in a safe, fun, girl-centered environment, and emphasize partnerships, public education campaigns, mentorship programs, career exploration, traditional badges, and innovative new programming.

By creating innovative, diverse and supportive learning environments, Girl Scouts takes a multi-faceted approach to increasing girls' interest in STEM. A few examples include:

- **Fair Play: Design & Discovery:** A proven, successful initiative run in partnership with the U.S. Department of Education and the Intel Corporation that teaches girls about STEM fields through extracurricular experiences. Program features include day and resident camp, after-school and university-based programs, and mentorship programs with women who are currently experts in physics, math, design, technology and computer engineering.
- **NASA Partnership:** Allows Girl Scouts to access NASA's cutting-edge technology and one-of-a-kind internships. Girl Scouts are able to attend solar science trainings and are given the opportunity to meet NASA scientists. This program also highlights the importance of role models for girls, whether they are astronauts, engineers, teachers, or local businesses that rely on STEM professionals.
- **Robotics:** Girls learn technology, engineering and computer programming skills through engagement with robotics programs offered through a national partnership with FIRST (For Inspiration and Recognition of Science and Technology). To date, in partnership with the Motorola Foundation, we have supported the startup of nearly 100 all girl First Lego League teams—and we will collectively support another 100 teams for the 2009–2010 season.

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[1] *Educational Equity of Girls and Women,* National Center for Education Statistics, 2000.

[2] The College Board, *Advanced Placement Report to the Nation: 2006* (February 2006).

[3] National Science Foundation, Division of Science Resources Statistics, *Women, Minorities, and Persons with Disabilities in Science and Engineering: 2004,* NSF 04–317 (updated May 2004). Available at *http://www.nsf.gov/statistics/wmpd*

[4] *Bayer Facts of Science Education Survey XIII: Fortune 1000 STEM Executives on STEM Education, STEM Diversity and U.S. Competitiveness.* Bayer Corporation (September 2008). *http://www.bayerus.com/MSMS/Survey/survey_13.aspx*

- **Public Awareness Campaigns:** Research indicates that girls exhibit early interest and ability in STEM subjects, but that adults actually tend to discourage girls from persevering. Girl Scouts partnered with the Ad Council in 2003 to produce an award winning, three-year public awareness campaign which aimed to change the cultural cues girls typically receive about STEM. By targeting girls, educators and parents and caregivers, this television, radio, online and print media campaign challenged influencers to "keep her interest alive."

WHAT WE'VE LEARNED: RESEARCH AND FUTURE PROGRAMS

In 2008, Girl Scouts of the USA partnered with the Puget Sound Center for Teaching, Learning, and Technology to identify promising practices in STEM education for girls. This study reaffirmed many of the findings from Girl Scout's century of experience in delivering STEM programming, and firmly established that the most effective STEM programming for girls includes:

- Hands on experiences
- Making curriculum relevant, tying it to real-life issues
- Project based learning opportunities
- Opportunities to work with STEM-field mentors
- Experienced program leadership.

With this research in hand, Girl Scouts developed an exciting new leadership journey called *It's Your Planet—Love It.* This innovative program uses girls' passion for the environment as a way to bolster their interest in STEM fields, and focuses on career exploration, hands-on activities, mentoring, and project-based learning in a girl-centric, supportive environment. The journey presents STEM subjects as fun, engaging, intimately tied to helping people and communities, and a natural part of daily life.

These materials were developed in partnership with experts in engineering, sustainable, agriculture, conservation, energy efficiency, and green building practices, and reviewed by science education professionals, engineers, staff at the U.S. Green Building Council, NASA, Motorola and others.

This journey—like *all* Girl Scouts programs—will be thoroughly evaluated, outcomes will be measured, and findings will be used to ensure that girls are developing the leadership skills they need. As we move forward with implementation of this program, our experience will no doubt inform and support public education, informal education, policy-makers, and other stakeholders on ways we can improve STEM education.

POLICY RECOMMENDATIONS

Based on our research and experience, Girl Scouts offers the following policy recommendations to improve both the formal and informal STEM education sectors. These recommendations reflect the crucial role played by informal education organizations in the development and delivery of programs that build the next generation of the STEM workforce. We support the expansion of programs that help organizations such as Girl Scouts to promote STEM education and career exploration, and to partner with and complement formal education, including:

- **Diverse Learning Environments:** Congress should expand efforts to teach STEM fields outside the classroom, in diverse settings. Specifically, expand educational opportunities where girls can explore, investigate, and experiment without fear of being teased or the social stigmas tied to girls who are interested in science. Efforts should be made to increase availability of "girl-only" programming to engage girls in STEM activities in safe, supportive, girl-centric environments.
- **Hands-on/Real World Learning:** Girls' interest in STEM significantly increases when it is provided in a hands-on, experiential student-led environment. Hands-on learning must also be tied to practical, real world applications. To ensure that we are engaging students in ways that capture their imaginations and interests, Congress should support efforts to expand hands-on, real world, collaborative learning in the informal educational setting.
- **Role Models:** Access to strong and inspiring role models and mentors is critical to engaging more girls in STEM fields. Congress should create and support mentoring programs to encourage young women to become involved in STEM education and careers, and should promote the work of non-profit organizations, collaborations with business and industry, and partnerships with

institutions of higher learning, with a special emphasis on programs that serve girls and women, minorities and people with disabilities.

- **Stigma-busting:** Stigma and stereotypes about STEM fields often keep girls from pursuing these careers. Congress should promote efforts to combat stigma through public education campaigns. As a leading authority on girls' interests and thinking, Girl Scouts is well-positioned to assist the government in reframing girls' (as well as their peers' and adults') perception of STEM to encourage more girls to engage in STEM fields.

CONCLUSION

As gaps in formal education increase, the informal education sector is ideally suited to work collaborative with schools and federal agencies to assure that girls' exposure and access to STEM fields are not lost. With our expertise on girls' development, a historical commitment to STEM, and a proven ability to deliver programs to girls in diverse communities across the country, Girl Scouts is uniquely positioned to help identify best practices and programming that provide a gateway of interest and active participation in STEM education. We look forward to working with the Committee to promote policy and programmatic proposals that address the gaps in STEM education, and increase the number of girls in this important field.