Bayer Facts of Science Education XIV

Female and Minority Chemists and Chemical Engineers Speak about Diversity and Underrepresentation in STEM

Survey Findings

For

March 2010

Table of Contents

Background and Methodology

Background and Methodology

Introduction

President Barack Obama's "Educate to Innovate" initiative, launched in 2009, is aimed at improving the participation and performance of America's students in science, technology, engineering, and mathematics or STEM. In particular, the initiative addresses the country's need to increase STEM literacy for all students and expand STEM education and career opportunities for those traditionally underrepresented in STEM fields, including females, African-Americans, Hispanics and American Indians.

The *Bayer Facts of Science Education XIV: Female and Minority Chemists and Chemical Engineers Speak about Diversity and Underrepresentation in STEM*[*] is the 14th in this annual public opinion research project commissioned by Bayer Corporation as part of its national award-winning *Making Science Make Sense*® program. It is also the fourth most recent *Bayer Facts* survey to examine the dual issues of diversity and underrepresentation by women and these minorities in STEM.

Until recently, women, African-Americans, Hispanics and American Indians have held few jobs in U.S. STEM fields. Recent reports from the Commission on Professionals in Science and Technology demonstrate that while women now hold more of these jobs, they, and these minority groups remain substantially underrepresented in a number of STEM fields including chemistry, engineering, physical sciences, mathematics and computer sciences.

Bayer began to illuminate these issues in 2005 when it polled parents of school-age children, including white, African-American, American Indian and Hispanic parents. In 2006, Bayer continued exploring these issues, this time from the perspective of CEOs who are running some of the fastest-growing STEM companies in the United States. More established STEM company CEOs, those leading Fortune 1000 STEM companies, were surveyed on these very same issues in 2008.

[*] The *Bayer Facts of Science Education* survey series is an annual public opinion research project commissioned by Bayer Corporation that helps gauge the state of science education in the United States, and measure the public's support for science education reform and recognition of the roles that science and science literacy play in everyday life. Since 1995, the surveys have polled a variety of audiences – from the nation's Ph.D. scientists and science teachers to parents, students and business executives – about a number of timely science education and science literacy issues.

Background and Methodology

With this survey, Bayer's goal is to add a critical voice to the national diversity/underrepresentation discussion – that of the female and minority STEM professionals themselves. Not only to continue the national conversation about these issues, but to uncover the root causes of underrepresentation and the key factors – both positive and negative, similar and disparate – that female and minority scientists encounter as they move along the U.S. STEM education pipeline and into the workplace.

Bayer extends its sincerest thanks to the American Chemical Society (ACS). To understand the experiences of female and underrepresented scientists, we turned to the ACS who, for the first time in its 134-year history, allowed an outside organization to survey its membership. By polling ACS members who are female, African-American, Hispanic and American Indian chemists and chemical engineers, we believe we have captured a number of experiences that may be common to female and minority scientists and engineers in other disciplines, as well.

In addition to probing their experiences, the survey also asks them to make recommendations to specific stakeholder groups about concrete actions they can take to attract and retain more women and minorities in STEM fields.

In 2000, the national report, "Land of Plenty: Diversity as America's Competitive Edge in Science, Engineering and Technology" (Congressional Commission on the Advancement of Women and Minorities in Science, Engineering and Technology Development) framed the STEM diversity issue as one of U.S. competitiveness. Since doing so, public awareness of STEM diversity as a national imperative has grown steadily. More than ever, many Americans recognize the need to tap the talent and creativity of all of our citizens and ensure everyone, regardless of gender, race or ethnicity, has a place at the STEM table, whether that place is in physics, chemistry, engineering, biotechnology or information technology.

In 2006, the National Academy of Science's report "Beyond Bias and Barriers: Fulfilling the Potential of Women in Academic Science and Engineering" closely examined the data, proposed explanations, and possible responses to the relative dearth of women in science and engineering higher education in the United States.

Background and Methodology

We hope the *Bayer Facts of Science Education XIV* survey findings will add another layer of understanding to the issue of underrepresentation from those with firsthand experience so that we, as a country, can knock down the barriers and provide to all of our budding scientists and engineers the attitudes, behaviors, opportunities and resources that lead to success.

Methodology

The results of this survey are based on an online and telephone poll of 1,226 female and underrepresented minority chemists and chemical engineers who are members of the American Chemical Society. Specifically, the survey includes the voices of Caucasian, Asian, African-American, Hispanic and American Indian female chemists and chemical engineers, and African-American, Hispanic and American Indian male chemists and chemical engineers.

A key goal of the survey was to understand the experiences and opinions of these scientists and engineers not necessarily as a monolithic group, but as individual groups whose members may share common experiences. For example, in the elementary school science classroom, did African-American women have the same experience as Caucasian women or Hispanic men? In some cases, the answer was yes and in others, no.

Sample

A minimum sample size of 1,050 was established to allow for sufficient base sizes in order to analyze the data by gender and race/ethnicity subgroups. The most recent National Science Foundation Scientists and Engineers Statistical Data System (*SESTAT*) occupation data was reviewed to establish minimum base sizes for the subgroups to be representative of the female and underrepresented minority chemists and chemical engineers working in the U.S. labor force and to identify any statistically significant differences among the groups. Minimum base sizes were identified as follows:

Caucasian women	533
Asian women	160
African-American men	75
African-American women	75
Hispanic men	82
Hispanic women	75
American Indian men	25
American Indian women	25

ACS drew the sample which included 17,527 of the female and underrepresented minority chemists and chemical engineers described above

with education levels including bachelor's, master's and doctorate degrees. The sample population consisted of regular, domestic ACS members between the ages of 25 and 65 who had worked for at least one year in a chemistry or chemical engineering capacity. The sample included those who received all or part of their pre-college, undergraduate and graduate education in the United States or in other countries.

An invitation letter, jointly signed by Greg Babe, President and CEO of Bayer Corporation and Madeleine Jacobs, Executive Director of ACS, was emailed and mailed to 5,050 ACS female and underrepresented minority members in November 2009, asking them to participate in the survey. Potential respondents were instructed to complete the online survey or sign up on a secure page of the survey company's Web site to complete a phone interview. Initially, 3,350 email and 1,700 mailed invitations were sent out.

In December 2009, an additional email/mailing was sent to the groups whose minimum base sizes had not yet been reached. These included American Indian men and women, African-American women and Asian women. Sufficient base sizes were ultimately achieved for all the groups, except for American Indian men and women due to low member population. Thus, while the voices of American Indian chemists and chemical engineers are included, the number of responses was not sufficient to determine significant differences between them and the other groups so no comparisons are made for them.

Similarly, it should be noted that ACS regular membership differs from the U.S. population of employed chemists and chemical engineers in two respects: proportion of doctorates (higher for ACS membership) and proportion of chemical engineers (lower for ACS membership). While the survey returned significant numbers of both chemists and chemical engineers, and of bachelor's and master's terminal degree holders, the data, reported for the demographic of those that responded, should be extrapolated to these groups with care.

The minimum base sizes were surpassed for the other groups and a total of 1,226 surveys were completed for a response rate of 25%. The actual base sizes were:

Caucasian women	582
Asian women	192

African-American men	112
African-American women	104
Hispanic men	101
Hispanic women	84
American Indian men	8
American Indian women	9
Other males	11
Other females	23

Based on this sample size, the statistical reliability achieved is +/-3 percent margin of error at a 95 percent confidence level.

Prior to the quantitative research described above being undertaken, qualitative research was conducted to understand the people and factors that were influential in the lives of these chemists and chemical engineers during their early childhood, educational and career development experiences. Again, working with the ACS, 10 female and underrepresented minority chemists and chemical engineers were identified and in-depth telephone interviews were conducted with them in July. The results of this qualitative research helped to shape the survey instrument.

In addition, comments from the in-depth interviews are included in this report where appropriate.

Chemists' and Chemical Engineers' Demographic Profile

The following summarizes the profile of all the female and underrepresented minority chemists and chemical engineers who participated in the survey:

Gender and Race/Ethnicity

- 81 percent of the sample was female; 19 percent was male.
- In terms of race/ethnicity and gender, the sample consisted of:

Race/Ethnicity	Total	Males	Females
Caucasians/Whites	47 percent	N/A	100 percent
Blacks/African-Americans	18 percent	52 percent	48 percent
East/West Asians	16 percent	N/A	100 percent
Hispanics/Latinos	15 percent	55 percent	45 percent
Other	2 percent	21 percent	79 percent
Native Americans/American Indian/Alaskan Native	1 percent	47 percent	53 percent
Native Hawaiian/Pacific Islander	1 percent	N/A	100 percent

Age and Years of Employment

- Two-thirds (65 percent) of the respondents were between the ages of 35 and 54, well-established in their careers. One-fifth (19 percent) were younger, between the ages of 25 and 34, while 14 percent were between 55 and 64 years old.
- Nearly two-thirds (64 percent) of those polled report being employed in a STEM field for 11 years or more. Twenty one (21) percent were employed for between 6 and 10 years and 15 percent are relatively new to the field with 1-5 working years under their belts.

Discipline and Education

- Nearly eight-in-ten (77 percent) considered themselves chemists, 6 percent chemical engineers and 5 percent both.
- Two-thirds (64 percent) have a doctorate degree. Of those, Asian women (72 percent), African-American men (71 percent) and Hispanic

men (71 percent) hold the most doctorates and African-American females (48 percent) the fewest.

- Sixteen (16) percent reported having a master's degree as their highest level of education completed, while 20 percent said their highest level of education was a bachelor's degree.
- The majority of respondents (71 percent) reported receiving their pre-college education (K-12) in the United States. Most Caucasian women (91 percent) and African-American women (84 percent) went to elementary and high school in the United States.
- Nearly three-in-ten (29 percent) indicated receiving their pre-college education outside the United States. The majority of Asian women (67 percent), Hispanic males (53 percent) and Hispanic females (54 percent) and a significant number of African-American men (44 percent) received their pre-college education outside of the United States.
- Nearly eight-in-ten (77 percent) of the respondents said they received their undergraduate college education and subsequent bachelor's degrees in the United States, while 22 percent said elsewhere.
- Those more likely to have received their undergraduate degrees in the U.S. included Caucasian women (92 percent), African-American women (86 percent) and African-American men (76 percent) compared to Hispanic men (59 percent) and Hispanic women (57 percent).
- Asian women (58 percent) were the most likely group to report going to college/undergraduate school outside the United States.
- More than four-in-ten (42 percent) indicated receiving a master's degree in the United States while 9 percent reported receiving a master's degree elsewhere. Again, Asian women (22 percent) were the most likely group to report receiving this advanced degree outside of the United States.
- More than half of the respondents (58 percent) indicated receiving a doctorate in the United States while 6 percent received a doctorate elsewhere. Asian women (10 percent) were slightly more likely than other groups to report receiving their doctorate outside of the United States.

Job Description

- The female and minority chemists and chemical engineers interviewed worked in a wide variety of areas, including applied research (21 percent), teaching (21 percent), basic research (15 percent), development (9 percent), quality control/assurance (8 percent), corporate management (5 percent) and manufacturing/processing (3 percent).

Analytical Notes

- For this study, the total sample size of 1,226 yielded results with a statistical accuracy of ±3 percent at the 95 percent confidence level. This means that there is a 1 in 20 chance that the "true" measurement will fall outside of this range.
- Where small sample sizes are noted with an asterisk, caution should be used when interpreting the results of subgroup analysis.
- Throughout the report, percentages may not add to 100 percent because of rounding and/or multiple responses.
- The term *net* is used in some tables in this report. *Net* is the summary of a group of related responses and represents the percentage of *respondents* who made one or more comments in that category/group.
- *Base* is the number of respondents who were asked a particular question. At times, questions are skipped by some respondents based on their answers to previous questions.
- A *top-two box* score refers to the two highest responses on a rating scale (for example, *excellent* and *very good*), that have been combined for reporting purposes.
- Several tables throughout the report show only the most frequently mentioned responses.

Key Survey Findings

Key Survey Findings

While overall the female and underrepresented minority chemists and chemical engineers polled were in general agreement on a host of issues, one important finding of the survey is that African-Americans register the strongest opinions on a variety of social and economic issues, including bias, stereotyping and the financial burdens of education. On some of these issues Hispanic men and women also feel strongly. On many issues where African-American men and women feel most strongly, Asian women feel least strongly.

In addition, other factors also affected opinions, including their gender and where they received their education. For example, barriers and bias were felt much more strongly by the chemists and chemical engineers who received all or part of their STEM education in the U.S. compared with those who attended school elsewhere.

All notable differences are reflected by the statements in italics.

I. Issues of Diversity and Underrepresentation in the U.S. STEM Workforce

"People from different backgrounds enhance the productivity of the team by bringing different viewpoints and experiences."

- A mid-career Asian female chemist

- More than three-quarters (77 percent) of those polled say significant numbers of women and under-represented minorities are missing from the U.S. STEM workforce today because they were not identified, encouraged or nurtured to pursue STEM studies early on.

  **More African-American men (91 percent) and women (88 percent) than Caucasian women (76 percent) and Asian women (63 percent) believe this to be the case.*

- Nearly two-thirds (63 percent) are concerned about the issue of underrepresentation of women, African-Americans, Hispanics and American Indians in the country's STEM fields, with one-third (34 percent) "very concerned" and 29 percent "concerned." Another 22 percent say they are "somewhat concerned."

  **African-American men (87 percent) and women (85 percent) tend to be most concerned and Asian women (43 percent) least concerned.*

  For those concerned, when asked why they were concerned, four-in-ten (44 percent) mentioned that diversity fosters U.S. global competition and economic solutions.

  **Compared to other groups, Asian women (32 percent) and Hispanic women (32 percent) mentioned it the least.*

  A concern for another four-in-ten (43 percent) respondents is that bias in the workplace makes it harder for women and minorities to enter STEM fields.

- Nearly two-thirds (63 percent) believe that underrepresentation by women and minorities in STEM threatens the United States' global competitiveness.

  **More African-American men (77 percent) and women (77 percent) believe this to be true than Asian women (46 percent).*

Key Survey Findings

- Almost as many (57 percent) agree with reports that suggest that bringing more women and minorities into these fields will help solve U.S. STEM manpower shortages.
  **More African-American men (79 percent) and women (71 percent) believe this to be true than Asian women (48 percent).*
- While an overwhelming majority (83 percent) of those chemists and chemical engineers polled say that a diverse workforce – one that includes significant numbers of women and minorities – is beneficial to their company's/organization's/institution's success, nearly two-thirds (62 percent) say underrepresentation exists in their company's/organizations/institution's workforce.
  **African-American men (77 percent) and women (79 percent) were more likely to say it exists in their workplace than Asian women (50 percent).*
- Fully one-third (33 percent) do not know if their companies/organizations/institutions have programs in place to recruit women and underrepresented minorities. Slightly more say these programs do not exist at their organizations (35 percent) than do (32 percent).

II. Causes/Contributors to Underrepresentation

- The factors that cause or contribute to underrepresentation are, in general, larger socio-economic issues, rather than personal or family/cultural issues, according to the female and minority chemists and chemical engineers.

Top Causes/Contributors to Underrepresentation in STEM	
Lack of quality science and math education programs in poorer school districts	75 percent
Stereotypes that exist that say STEM isn't for girls or minorities	66 percent
Financial issues related to the cost of education	53 percent
The fact that the STEM industries don't communicate the message to women and minorities that they are wanted and needed in these fields	51 percent

**Cultural issues played less of a role, though a significant portion of African-American men (33 percent) and women (38 percent), and Hispanic men (24 percent) and women (23 percent) cited the fact that their "cultural backgrounds didn't completely understand what scientists and engineers do."*

**Only 5 percent of Asian women cited this fact as a cause/contributor.*

"Going into science was unheard of in my family. I had to believe in myself that I was smart enough to succeed."
– A mid-career American Indian female chemical engineer

"A definite bias existed in my neighborhood growing up. I was asked why not do something with your hands? Blacks don't do chemistry. Why you?"

- A mid-career African American male chemistry professor

"I was the first in my family to go to college. There was just a complete lack of understanding. They were a very traditional family in their views that boys do everything."

- A mid-career Asian female chemist

III. Developing an Interest in Science

- Overall, for those chemists polled, interest in science began at an early age, regardless of gender, race or ethnicity. A majority, six-in-ten (59 percent) said they first became interested before age 11. This parallels the findings of a 1998 Bayer Facts survey of American Ph.D. scientists, which included white men. In that survey, six-in-ten also reported interest in science by age 11.

  **African-American men (21 percent) were the most likely group to report interest at four years or younger.*

  **African-American women (26 percent) were the most likely group to report interest between 14 and 17 years old.*

"I always wanted to know how things worked. My parents did not believe in stereotypes and encouraged my interests. They would buy me science kits and take me to science camps and other activities."

- A mid-career Caucasian female scientist

- Across the board, those polled said their school science classes were the most important factor in stimulating their interest in science.

Important Factors in Stimulating/Sustaining Interest in Science	
School Science Classes	84 percent
Visits to Science Museums	63 percent
Science in Media	62 percent
Science Field Experiences	56 percent
Science Toys/Equipment	53 percent
Science Experiments at Home	44 percent

**Hispanic men (71 percent) and women (70 percent) and Asian women (72 percent) were more likely to call "Science in Media" important.*

**African-American men (64 percent) and Hispanic men (70 percent) and women (65 percent) were more likely to call "Science Toys and Equipment" important.*

**"Science Experiments At Home" were important influencers for African-American men (53 percent) and Hispanic women (61 percent).*

** Males were much more likely than females to consider the following activities/resources important factors:*

- *Science Toys and Equipment (69 percent vs. 49 percent);*
- *Science Experiments at Home (53 percent vs. 43 percent); and,*
- *Visits to Science Labs (45 percent vs. 36 percent).*

** Females (65 percent) were more likely to consider "Visits to Science Museums" an important factor than males (55 percent).*

Key Survey Findings

- In terms of the individuals who were most important in stimulating and/or sustaining their interest in science at both the elementary and high school levels, science teachers were cited as being most important by all of the chemists/chemical engineers polled.

Important Individuals Who Play a Role in Stimulating/Sustaining Interest in STEM		
	ELEMENTARY SCHOOL (K-8)	*HIGH SCHOOL (9-12)*
Science Teachers	70 percent	88 percent
Father	54 percent	53 percent
Mother	46 percent	47 percent
Professional Scientists	26 percent	38 percent
Other Relatives	26 percent	25 percent
Non-science Teachers	21 percent	28 percent

- In addition, nine-in-ten (93 percent) of the chemists and chemical engineers polled report their parents encouraged them to do well in school overall. Another 57 percent said their parents both emphasized science as an important subject for them to be leaning and encouraged them to learn about science on their own through books and other materials.

- Given the level of importance placed on early childhood science experiences and despite the high regard for their own science classes and teachers, the chemists/chemical engineers polled were generally critical of the quality of today's pre-college science education.

  Almost half (46 percent) assign a "D" or "F" to the quality of today's elementary school science education compared with only 11 percent who give it an "A" or "B."

  High school science education fared somewhat better, but not that much. One-third (35 percent) mark it a "D" or "F," while only 16 percent give it an "A" or "B." Some 38 percent give it a "C."

Report Card for Today's U.S. Elementary and High School Science Education Average Grade	
Elementary School (K-8)	D+
High School (9-12)	D+

- In today's elementary schools, the vast majority (84 percent) say that science should be the fourth "R" and given the same priority as reading, writing and mathematics. However, most (68 percent) say this is not presently the case and that science is given too little emphasis compared with the other subjects.

"Teachers shy away from Science in elementary school. They usually only focus on Reading and Math."

- A mid-career Caucasian female scientist

Key Survey Findings

- When asked what is the most effective method for teaching science to students – hands-on, inquiry-based methods or traditional textbook/memorization methods – the majority (53 percent) said both are equally important, while 46 percent selected the hands-on, inquiry-based approach only.

  **Those who received their pre-college education in the U.S. (52 percent) were much more likely to consider "hands-on experiments, form opinions, and discuss and defend their conclusions with others" as the most effective method for teaching science compared to those who received their pre-college education outside the U.S. (32 percent).*

  **Those who received their pre-college education outside of the U.S. (67 percent) compared to in the U.S. (48 percent) were more likely to say both are equally important.*

- Not surprisingly, almost all the female and minority chemists (96 percent) believe it is "extremely important" or "important" for Americans, both STEM professionals and non-STEM professionals alike, to be science literate in today's world.

"Our schools are not adequately addressing science literacy and building the confidence of our young women and minorities. Many are not prepared to take on higher degrees."

- An early-career African-American female chemist

IV. Bias in the Classroom

- Despite their early childhood interest in science and the importance the chemists/chemical engineers place on their science teachers and science classes, the survey did detect bias against girls and minorities in their elementary and high school science classrooms.

  For example, while half polled do say that in elementary (50 percent) and high school (52 percent), girls were encouraged the same as boys in science classes, one-quarter disagree, saying girls were encouraged less than boys in elementary school (28 percent) and high school (27 percent).

  "There is a lack of encouragement in elementary school… the younger you get girls and minorities to see it's okay to like science and math the more likely they are to pursue it."

  - A mid-career Caucasian female scientist

  **A full one-third (33 percent) of Caucasian women say girls were encouraged less than boys in both elementary and high school science classes.*

  **When in elementary school, those who received their pre-college education in the U.S. (32 percent) were much more likely to feel that girls were encouraged less than boys compared to those who received their pre-college education outside the U.S. (17 percent).*

  **Asian women were the least likely to believe this was true (14 percent elementary; 18 percent high school).*

- For minority students, one-third of those polled said these students were encouraged the same as non-minority students in elementary school (33 percent) and high school (34 percent).

  **Roughly one-quarter of African-American men (28 percent) and women (26 percent) said in elementary school minorities were encouraged less than non-minorities, and roughly one-third of the African-American men (31 percent) and women (38 percent) said this was the case in high school.*

  **Those who received their pre-college education in the U.S. were much more likely to feel that underrepresented minority students were encouraged less than non-minority students in science in elementary (19 percent) and high school (22 percent), compared to those who received their pre-college education outside the U.S. (7 percent elementary and 10 percent high school).*

  "Our society prescribes to this stereotypical behavior. Only girls can play with dolls and only boys can play with Legos."

  - A mid-career Caucasian female scientist

  **Males were much more likely to feel that underrepresented minority students were encouraged less than non-minority students in science in elementary (23 percent) and high school (26 percent) than females (13 percent elementary and 17 percent high school).*

- According to the female and minority chemists/ chemical engineers polled, this bias still exists today in the U.S. education system along the academic pipeline, particularly at the pre-college level. When asked how good a job they think today's U.S. education system does in engaging and nurturing girls and underrepresented minorities to pursue STEM careers, those polled assigned notably lower grades to the pre-college (K-12) level. The higher education system fared slightly better, but not much.

"Underprivileged school districts have difficulty attracting quality Science teachers."

- A mid-career American Indian male chemistry professor

For girls at the pre-college level, more chemists and chemical engineers (38 percent) assign a "D" or "F" than an "A" or "B" (14 percent) to the system for the job it does. For minorities, the grades are worse. More than half (51 percent) grade the pre-college system a "D" or "F," while only 6 percent give it an "A" or "B."

**Some three-quarters of African-American men (73 percent) and women (74 percent) gave a "D" or "F" to the pre-college education system for the job it does engaging minorities.*

"Poorer districts usually don't offer lab experiments due to lack of funding and liability issues."

- A mid-career African American male chemistry professor

At the college/graduate school level, the U.S. academic system does a better job training females than minorities for STEM careers, according to the chemists/chemical engineers. Half (50 percent) assign the higher education system an "A" or "B," while only 12 percent give it a "D" or "F."

For the training job it does with minorities, the higher education system receives an "A" or "B" from one-third (32 percent) and a "D" or "F" from one-quarter (23 percent) of those polled. However, less than one-in-ten (9 percent) assign it an "A" grade.

**African-American men (50 percent) and women (31 percent) are most likely to give the higher education system a "D" or an "F."*

Report Card for Today's U.S. Education System in Engaging/Nurturing Girls and Underrepresented Minorities in STEM
Average Grades

	Pre-College (K-12)	Higher Education
Girls	D+	C+
Underrepresented Minorities	D	C

V. Discouragement Along the STEM Pipeline

- When asked if they had ever been discouraged by individuals during the course of their successful pursuit of a STEM career, four-in-ten (40 percent) say, yes, they were discouraged.

  **Half (50 percent) of the African-American men and Hispanic women chemists/chemical engineers say they were discouraged.*

  **Fewer Asian women (28 percent) and Hispanic men (31 percent) report being discouraged.*

  **Those who received their pre-college (43 percent), undergraduate (42 percent) and graduate (42 percent) education in the U.S. indicated discouragement much more often than those who received their pre-college (33 percent), undergraduate (34 percent) and graduate (29 percent) education outside the U.S.*

- College professors (44 percent) were cited most frequently as the individual responsible for the discouragement.

Individuals Who Discouraged Pursuit of STEM Career	
Professors	44 percent
Colleague	29 percent
Parent or family member	26 percent
Guidance counselor/advisor	24 percent
Teacher	21 percent

**African-American women (65 percent) indicate a professor most often and Asian women (28 percent) least often.*

**African-American men (34 percent) and women (30 percent) and Hispanic women (31 percent) were the most likely groups to report being discouraged by a guidance counselor/ advisor.*

Key Survey Findings

- For the male and female chemists/chemical engineers who were discouraged, most cite college as the place it happened.

Places Where Discouragement of STEM Career Happens	
College	60 percent
High School	41 percent
Workplace	35 percent

**Asian women chemists were more likely than other groups to identify the workplace (51 percent) as the place where discouragement occurred.*

"I was told at one point that I was a token and that I would never make it. I knew I'd have to work extra hard to be three times as good to be respected. I wasn't sure I could work hard enough."

- A mid-career Caucasian female scientist

VI. Respondents' Significant Pre-College Barriers and Opportunities

- While it varied somewhat by gender and racial/ethnic background, a number of barriers were cited fairly consistently by all groups across the board as challenges they themselves faced. Notable differences, high and low, among the groups are indicated by the information in italics. (Blank cells indicate responses were similar to "All.")

Significant Barriers Faced in Pursuing Pre-College STEM Studies						
	All	*African-American Men*	*African-American Women*	*Hispanic Men*	*Hispanic Women*	*Asian Women*
Lack of Mentors	50 percent	*62 percent*	*71 percent*	–	–	–
Lack of Role Models	49 percent	–	*61 percent*	–	–	*33 percent*
Stereotypes Existed that Say STEM Isn't for Girls and Minorities	39 percent	–	–	*27 percent*	–	*28 percent*
STEM Industries Didn't Communicate to Women and Minorities that They are Wanted and Needed in STEM Fields	39 percent	–	*50 percent*	–	–	–
Lack of Confidence/ Self-Doubt	35 percent	–	–	–	–	*26 percent*
Financial Issues Relating to the Cost of Education	31 percent	*51 percent*	*47 percent*	*54 percent*	*45 percent*	*17 percent*
Sense of Isolation	29 percent	*43 percent*	*39 percent*	–	–	–
Lack of Quality Science and Math Education in Poorer School Districts	24 percent	*47 percent*	*39 percent*	*43 percent*	–	–

*Those who received their pre-college education in the U.S. were much more likely to consider the following as significant barriers/challenges than those who received their pre-college education outside the U.S.:

- *Lack of role models (54 percent vs. 36 percent);*
- *The STEM industries didn't communicate to women and minorities that they were needed and wanted in STEM fields (44 percent vs. 29 percent);*
- *Stereotypes existed that say STEM isn't for girls and minorities (44 percent vs. 30 percent);*
- *Lack of confidence/self-doubt (39 percent vs. 24 percent);*
- *Sense of isolation (32 percent vs. 21 percent); and,*
- *My cultural background didn't understand what scientists/engineers do (18 percent vs. 9 percent).*

"Many underprivileged students are forced to quit school in order to get a job and help support their family."

- A late-career Asian female chemistry professor

"It's harder for poorer minorities to get a good education… the majority of urban or reservation Native Americans do not have access to a very good K-12 education."

- A mid-career American Indian female chemical engineer

- When it comes to significant opportunities, the female and underrepresented chemists and chemical engineers all name essentially the same things. The most significant positive factor for all was their own "strong personal interest in science." Notable differences are indicated in italics, while blank cells indicate responses were similar to "All."

Significant Opportunities in Pursuing Pre-College STEM Studies						
	All	*African-American Men*	*African-American Women*	*Hispanic Men*	*Hispanic Women*	*Asian Women*
Strong Personal Interest in Science	82 percent	–	–	–	–	–
Supportive Parents and/or Family Members	69 percent	–	–	–	–	–
Inspiring and Dedicated Teachers	66 percent	–	–	–	–	–
Self-Confidence	42 percent	*56 percent*	–	*54 percent*	–	–
Challenging Curriculum/ Abundance and Variety of STEM Classes	33 percent	–	–	–	–	–
Access to/ Participation in Extracurricular Activities	24 percent	–	*-31 percent*	–	–	*15 percent*
Strong Role Models	22 percent	–	*15 percent*	–	–	*31 percent*
Scholarships/Financial Assistance	19 percent	*31 percent*	*31 percent*	–	–	–

** Those who received their pre-college education outside of the U.S were much more likely to consider the following as significant opportunities compared to those who received their pre-college education in the U.S.:*

- *Self-confidence (52 percent vs. 38 percent) and*
- *Scholarships/financial assistance (23 percent vs. 17 percent).*

VII. Respondents' Significant College/Graduate School Barriers and Opportunities

- At the college/graduate school level, the barriers cited varied somewhat by gender and racial/ethnic background, but were generally consistent. However, African-American women cite several key barriers more often than other groups. Once again, notable differences, high and low, among the groups are indicated by the information in italics and empty cells mean responses were similar to "All."

Significant Barriers Faced in College/Graduate School in Pursuing STEM Career						
	All	*African-American Men*	*African-American Women*	*Hispanic Men*	*Hispanic Women*	*Asian Women*
Lack of Role Models	35 percent	–	*45 percent*	–	–	–
Lack of Mentors	34 percent	–	*45 percent*	–	–	–
Lack of Confidence/ Self-Doubt	33 percent	*18 percent*	–	*23 percent*	–	–
Financial Issues Relating to the Cost of Education	32 percent	*48 percent*	–	*50 percent*	*44 percent*	*19 percent*
Sense of Isolation	31 percent	*54 percent*	*45 percent*	–	–	*19 percent*
STEM Industries Didn't Communicate to Women and Minorities that They are Wanted and Needed in STEM Fields	31 percent	–	–	–	–	–
Stereotypes Existed that Say STEM Isn't for Girls and Minorities	29 percent	–	*39 percent*	*16 percent*	–	*16 percent*
Limited Quality Science and Math Education	17 percent	–	*26 percent*	–	*27 percent*	–

**Females (36 percent) were more likely to cite lack of confidence than males (20 percent).*

Key Survey Findings

- In college/graduate school, the chemists/chemical engineers surveyed overwhelming cite their own "strong personal interest in science" as the most significant factor influencing their pursuit of a STEM career. Here again, the influencers were similar for groups across the board.

Significant Opportunities in College/Graduate School in Pursuing STEM Career						
	All	*African-American Men*	*African-American Women*	*Hispanic Men*	*Hispanic Women*	*Asian Women*
Strong Personal Interest in Science	86 percent	–	–	–	–	–
Inspiring and Dedicated Professors	64 percent	–	–	–	–	–
Supportive Parents and/or Family Members	63 percent	–	–	–	–	–
Internships/Research Opportunities	49 percent	–	–	–	–	–
Challenging Curriculum/ Abundance and Variety of STEM Classes	47 percent	–	–	–	–	–
Self-Confidence	44 percent	*65 percent*	–	*60 percent*	–	–
Scholarships/Financial Assistance	43 percent	*58 percent*	*56 percent*	*60 percent*	–	–
Participation in Professional Scientific Society Activities	36 percent	–	–	–	–	–
Access to Mentors	29 percent	–	–	–	–	–
Strong Role Models	24 percent	–	–	–	–	–

**Self-confidence and scholarships both were selected more often by males (62 percent and 57 percent) compared to females (39 percent and 40 percent).*

"There were certain communication barriers I had to overcome in graduate school. The expectation was that I wouldn't do well and that I needed to be three times as good as everyone else. I had a lot of self doubt. In order to build my confidence I had to build social relationships and gain the trust of my peers. Many women and minorities don't survive."

\- An early-career African-American female chemist

VIII. Important Resources, Opportunities and Individuals Along The Way

- According to 82 percent of the chemists/chemical engineers polled, high school programs geared toward females and underrepresented minorities that involve scholarships and internships are important for today's female and underrepresented minority students wishing to pursue STEM careers. Some 55 percent said they are "extremely important."

  **African-American men (71 percent) and women (87 percent), and Hispanic men (68 percent) and women (71 percent) are most likely to call these opportunities "extremely important."*

"Many minorities don't know how to get scholarships. I learned about them in my high school career center and through the American Chemical Society in college."

- An early-career Hispanic female chemist

- At the college and graduate school level, the same is true. Some 86 percent call these scholarship, internship and fellowship opportunities important, with 59 percent calling them "extremely important."

  **African-American men (78 percent) and women (81 percent), and Hispanic men (73 percent) and women (74 percent) are most likely to call them "extremely important."*

- In high school, few of the chemists/chemical engineers (17 percent) report having access to/participating in/receiving scholarships and internships. Of those who did, two-thirds (64 percent) said they were "extremely important;" another 22 percent said they were "important."

  **African-American women (34 percent) were most likely to say they had received these opportunities and of those 100 percent said they were "important."*

  **Those who received their pre-college education in the U.S. (20 percent) were much more likely to report that they had access to these scholarships or internships compared to those who received their pre-college education outside the U.S. (10 percent).*

- In college/graduate school, more chemists/chemical engineers report having access to/ participating in/receiving scholarships, internships and fellowships (42 percent). Of those who were fortunate enough to have these opportunities, some 82 percent said they were important; six-in-ten (61 percent) said they were "extremely important."

  ***Males (53 percent) were more likely to report that they had access to these scholarships/ internships in undergraduate/graduate school compared to females (39 percent).*

  **Those who received their undergraduate (45 percent) and graduate (45 percent) education in the U.S. were much more likely to report that they had access to these scholarships or internships compared to those who received their undergraduate (32 percent) and graduate (29 percent) education outside the U.S.*

  **Hispanic men (93 percent), African-American men (93 percent), Hispanic women (88 percent), and African-American women (91 percent) were the groups most likely to consider these opportunities important.*

Key Survey Findings

- In high school, there are a number of factors considered important for today's female and minority students wishing to pursue STEM careers.

Important Factors for Today's High School Students Wishing to Pursue STEM Careers	
Role Models	92 percent
Mentors	92 percent
Research/Internship Opportunities in Labs	82 percent
Extracurricular Activities (Science Camps, Clubs and Museums)	79 percent
Classroom Visits by Professional Scientists	76 percent

**African-American women were more likely to place greater importance on research/internships in labs (94 percent); extracurricular activities (92 percent); and, classroom visits by professional scientists (88 percent).*

- For today's undergraduate and graduate students pursuing STEM careers, important factors cited by the chemists/chemical engineers include:

Important Factors for Today's College Students Wishing to Pursue STEM Careers	
Research/Internships Opportunities in Labs	94 percent
Mentors	93 percent
Role Models	91 percent
Career Programs Designed for Women and Minorities	52 percent

**Career programs designed for women and minorities were most likely to be cited as important by African-American women (75 percent).*

"My ethnicity helped me apply for certain scholarships, but it was also hurtful because I was never exposed to any role models or people like me who had careers in this field."

- An early-career Hispanic female chemist

"My secondary education didn't provide enough of a solid background in the basics. If it wasn't for the extracurricular activities like the science club and camps, I wouldn't have been equipped to excel as well."

- A mid-career Caucasian female scientist

IX. Respondents' Workplace Challenges and Road to Success

- Today's STEM workplace is still more of challenge for women and minorities than it is for men and non-minorities, say those polled.
- In general, almost three-quarters (70 percent) say it is harder for women to succeed in their field than it is for men.

  **African-American women (88 percent) are most likely to believe this is true and Hispanic men (41 percent) are least likely to believe this is so.*
- As for minorities, two-thirds (67 percent) think it is more difficult for them to succeed than it is for non-minorities.

  **African-American men (90 percent) and women (91 percent) and Hispanic women (82 percent) are most likely to believe this is the case.*

"Entrance positions are not a problem. But after the first 10 years of your career, women and minorities start losing ground with their peers. Small disadvantages and biases accumulate over time."

- A mid-career American Indian Female Chemistry Professor

- Across the board, they give their companies/organizations/institutions a "C" for having women and underrepresented minorities in senior positions to serve as role models and mentors for the younger generation.

"My organization lacks sensitivity to minorities. They don't understand how diversity can make them a better organization and they don't understand how to encourage it. ACS has really helped support underrepresented minorities. They gave me the opportunity to be a leader that my organization never will."

- A mid-career American Indian female chemical engineer

"We still have to overcome bias. We work extra hard to show knowledge and not be overlooked or be perceived as not worthy. There is a different type of managerial speak. We have a Hispanic leadership team at my organization to help new hires."

- An early-career Hispanic female chemist

Key Survey Findings

- Bias and lack of opportunity take center stage as the leading workplace barriers for the chemists/chemical engineers surveyed, and in most cases, African-Americans felt both more strongly than the others. Here again, notable differences, high and low, among groups are indicated by information in italics. Groups whose responses were similar to "All" are noted with an empty cell.

Leading Workplace Barriers/Challenges			
	All	*African-American Men*	*African-American Women*
Managerial Bias	40 percent	*48 percent*	--
Company/Organizational/Institutional Bias	38 percent	--	*56 percent*
Lack of professional development opportunities	36 percent	--	*46 percent*
No/little access to networking opportunities	35 percent	*46 percent*	*50 percent*
Lack of promotion/advancement Opportunities	35 percent	*40 percent*	*40 percent*
Sense of isolation	34 percent	*49 percent*	*55 percent*

- Lack of role models and mentors, and lack of confidence became less significant barriers in the workplace than they were in school for those polled.

  **However, a significant number of African-American women (46 percent) say lack of committed mentors and lack of role models (40 percent) were barriers for them at work.*

  **A lack of self-confidence was selected as a significant barrier/challenge more often by females (27 percent) than by males (17 percent).*

- On the positive side, an overwhelming number of those polled (83 percent) say that given everything, if they had to do it over again they would still choose a career in STEM.

"I feel very good about my life's work. I'm giving back to the community, contributing to the future and making a better life for all."

- A mid-career American Indian male chemistry professor

- A variety of significant influences/opportunities were cited by the chemists/chemical engineers as having helped them succeed.

Leading Workplace Opportunities/Influences	
Creating professional relationships	61 percent
Achieving work/life balance	55 percent
Building networks within their organizations	40 percent
Having supportive management behind them	37 percent
Joining professional societies or networking groups	37 percent
Working in an organization that is truly inclusive	33 percent
Having access to interested and committed mentors	33 percent
Having access to advancement opportunities	30 percent

**African-American women were more likely to name "joining professional societies or networking groups" as a significant influence/opportunity (46 percent).*

X. Recommendations to Stakeholders for Improving STEM Education

- The chemists and chemical engineers polled offered their own recommendations for key stakeholders on how they can help ensure female and underrepresented minority success in STEM fields. The most often cited are listed below:

Stakeholder Group	Key Recommendations
Pre-College (K-12) Teachers/Educators	✓ Encourage and support interest and passion in science ✓ Be proficient in science and science education ✓ Offer more hands-on science experiences ✓ Teach without bias ✓ Provide stronger K-12 science curriculum and classes ✓ Make science exciting, interesting and fun
Colleges/Universities	✓ Offer scholarships, fellowships and grants ✓ Provide mentors, mentoring and role models ✓ Hire and promote more women and minority science faculty ✓ Encourage, engage and be involved with students ✓ Provide internships ✓ Recruit and admit, actively, women and minorities ✓ Create, encourage and support student groups for women and minorities
Parents	✓ Encourage your children in STEM activities and interests ✓ Encourage your children to explore science outside of school ✓ Encourage your children to consider and pursue STEM careers ✓ Be involved in your children's science education ✓ Challenge your children with high expectations
Government	✓ Offer scholarships, fellowships and financial aid ✓ Increase financial support for STEM education at all levels ✓ Support and fund STEM education programs for women and minorities ✓Encourage and support STEM organizations and programs that support women and minorities ✓ Recruit, hire and promote women and minorities for STEM jobs

Stakeholder Group	Key Recommendations
Females and Minorities Themselves	✓ Set high standards, work hard and never give up ✓ Develop self-confidence ✓ Serve as mentors and role models ✓ Build/take advantage of peer networks and support groups ✓ Don't let anyone tell you you can't ✓ Take the initiative and assert yourself ✓ Be open to/seek opportunities
STEM Corporations	✓ Recruit, hire and promote women and minorities for STEM jobs ✓ Provide mentors, mentoring and role models ✓ Offer high school and college internship opportunities ✓ Encourage and support STEM organizations and programs that support women and minorities ✓ Get involved with elementary, middle and high school STEM education ✓ Create and support family-friendly policies and working environments ✓ Communicate broadly about STEM importance and opportunities
STEM Professional Societies/Organizations	✓ Provide mentors, mentoring and role models ✓ Build and support peer networks for women and minorities ✓ Recruit, actively, women and minorities for professional society membership ✓ Get involved with elementary, middle and high school STEM education ✓ Communicate broadly about STEM importance and opportunities ✓ Support women and minority STEM programs in your organization

* * * *