

**Bayer Facts of Science Education XV:
A View from the Gatekeepers –
STEM Department Chairs at
America's Top 200 Research Universities on
Female and Underrepresented Minority
Undergraduate STEM Students**

EXECUTIVE SUMMARY

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Introduction

Diversity and the underrepresentation of women, African-Americans, Hispanics and American Indians in the nation's science, technology, engineering and mathematics or STEM fields are once again the subjects of the 2011 *Bayer Facts of Science Education* survey.

An annual public opinion research project commissioned by Bayer Corporation since 1995, the *Bayer Facts* surveys examine key issues related to science education and science literacy in general and in recent years to STEM more specifically.

The 15th in the *Bayer Facts* series, this survey is the fifth to explore issues of diversity and underrepresentation. It also is a direct outgrowth of last year's research. That survey found four-in-10 or 40 percent of the country's female and underrepresented minority (URM) chemists and chemical engineers working in their field today were discouraged from pursuing their STEM career at some point in their lives. U.S. colleges were cited as the leading place in the American education system where this discouragement happened and college professors as the individuals most likely responsible.

Does such inappropriate discouragement still occur today in American colleges and universities? To answer this question and others about the undergraduate environment in which today's female and URM STEM students make their career decisions, the 2011 survey asks those in charge – faculty who chair STEM departments at the nation's 200 top research universities and those colleges that produce the highest proportion of female, African-American, Hispanic and American Indian STEM graduates.

This is a critical audience. In the U.S. STEM education pipeline, college STEM departments are important gatekeepers to STEM careers – indeed one of the most important links in the chain.

The views of the STEM department chairs add an important, and to date, unheard voice to the national discussion about how we, as a country, broaden student participation in STEM to include more women and URMs.

The survey asks them to weigh in on questions, including:

- How good a job is their institution doing when it comes to retaining and graduating female and URM students?
- Do today's students, including females and URMs, enter college with adequate academic preparation to complete studies and graduate with STEM degrees?
- Has the issue of recruiting and retaining undergraduate women and underrepresented minority STEM students reached a point at the nation's research colleges/universities where it needs to be addressed by the highest institutional leadership?
- Do their institutions have formal STEM diversity plans with specific recruitment and retention goals and an ongoing evaluation process to assess effectiveness?
- Are undergraduate STEM courses that "weed out" students from STEM majors beneficial or harmful?

This survey is particularly timely.

First, with initiatives including Race to the Top, Educate to Innovate and Change the Equation, President Barack Obama continues to highlight the connection between innovation, U.S. competitiveness and STEM, and make STEM education and STEM diversity key priorities of his administration.

Additionally, three new reports from the U.S. Department of Commerce make the strong case for education and diversifying the STEM workforce. *STEM: Good Jobs Now and for the Future* shows how U.S. employment in these critical fields drives our nation's innovation and competitiveness, highlighting the fact that "STEM workers are helping America win the future by generating new ideas, new companies and new industries."

And earlier this year, the National Academies released the report "Expanding Underrepresented Minority Participation: America's Science and Technology Talent at the Crossroads." The report examines URM participation in STEM at every education level and highlights best practices and the characteristics that make these practices effective and sustainable. At the undergraduate college level, it profiles model programs that are effective and calls for other American colleges to reassess their current approaches in favor of those that are successfully seeing URM STEM undergraduates to course completion and graduation.

Bayer would like to thank the authors of this report, in particular. Their articulation of top priority actions for American colleges and universities, description of best practice recruitment and retention programs, and recommendations to the colleges and universities, including the top research institutions, for URM STEM undergraduate retention and completion, greatly informed the development of the current survey questionnaire.

Understanding the STEM undergraduate environment at the country's leading research universities is the first step toward making reforms designed to boost student participation and bring all of the nation's STEM talent, regardless of race or gender, to the table.

NOTE

- In this survey, underrepresented minorities (URMs) are defined as African-American, Hispanic and American Indian males and females and Asian females.
- Also, for the purposes of this study, majority students are defined as Caucasian and Asian males.

Methodology

A total of 413 online surveys were completed using a list of STEM department chairs/heads from the country's top 200 research colleges/universities, as well as those that produce the most African-American, Hispanic and American Indian STEM graduates (e.g., historically black colleges and universities, etc.), based on survey data from the National Science Foundation.

To uncover individual STEM department chairs, this list was cross-referenced against the National Research Council's *Data Based Assessment of Research-Doctorate Programs* (NRC, 2010) which included 62 fields of study at 212 institutions. This list was narrowed to include only core STEM fields in Agricultural Sciences, Biological Sciences, Computer Sciences, Engineering, Mathematical Sciences and Physical Sciences and augmented to include high-productivity minority-serving institutions. The final sample included 3,787 STEM departments in 214 institutions.

Respondents were first invited to participate in the survey via a letter from Bayer Corporation's President and CEO, Greg Babe. The letter described the purpose of the research and contained a web link to the survey. Within a week of receiving the mailed letter invitation, an email invitation was also sent. Two weeks later a second "reminder" invitation was emailed to further boost participation. The number of completed surveys (413) far exceeded the original target of 200. Particularly in light of the time of year (May through early June), the response was much better than expected. At close of the field period, the overall response rate was over 9% (a total of 3,787 invitations were mailed/emailed and 413 STEM department chairs completed the online survey).

Respondents' departments were identified by STEM field of study using the NRC's typology. Final STEM categories included in the sample were (see demographic section for detailed list of departments):

- Agricultural Sciences
- Biological Sciences
- Computer Sciences
- Engineering
- Mathematical Sciences
- Physical Sciences

Qualified respondents met screening criteria that confirmed they currently:

- Chair or head a department at their college or university
- Chair or head a department in one of the 34 predetermined STEM categories
- Chair or head a department that teaches undergraduate courses

Based on the sample size, the statistical reliability achieved is +/- 4.5% margin of error at a 95% confidence level. Data was weighted to reflect the NRC classifications by region and field of study.

Demographic Profile

The following summarizes the profile of all the STEM department chairs (n=413) surveyed.

- Nearly nine-in-10 of the STEM department chairs surveyed are male (87% vs. 13% female) and Caucasian (88% vs. 13% other races*). Of the 13% who report being non-Caucasian, the largest number (7%) are Asian.
- The majority (53%) are between the ages of 51 and 60. The remaining chairs are split between those who are 50 and younger and those over 60 years old.
- The STEM department chairs head departments spanning six broad areas of study including biological sciences (29%), engineering (28%), physical sciences (20%), agricultural sciences (11%), mathematical sciences (8%) and computer sciences (5%).

Within those broad areas, the STEM department chairs identify specific department fields of study. For example, within engineering, the chairs report heading departments in mechanical engineering (6%), chemical engineering (4%), electrical and computer engineering (4%), and civil and environmental engineering (3%), among others.

- Most (85%) teach at the nation's top 200 research colleges/universities. These are:
 - * public (80% vs. 20% private);
 - * large (77% have undergraduate student bodies of 10,000 or more); and, have
 - * large STEM departments (74% have 100 or more undergraduate students in their STEM department).
- The remaining 15% teach at colleges that grant a high proportion of STEM baccalaureate degrees to female and URM STEM students, including historically black colleges/universities, Hispanic-serving institutions and tribal colleges/Native American-serving institutions.
- This year, their departments will grant STEM degrees to more males (58%) than females (42%).

*Multiple responses allowed

KEY FINDINGS

STEM Diversity in U.S. Higher Education and the U.S. Workforce

STEM diversity is both necessary and beneficial to America's leading research universities and U.S. competitiveness.

- Almost all STEM department chairs surveyed agree that increasing the number of women (83%) and URM (90%) in both STEM education and the country's STEM workforce is an important national need.
- Almost all – more than nine-in-10 – believe a diverse STEM student population is beneficial to their institution's academic success and the country's long-term economic competitiveness.

While STEM diversity has reached critical mass at the nation's top research universities, the vast majority do not have comprehensive, institution-wide STEM diversity programs in place.

- A large majority – seven-in-10 – of STEM department chairs say that the issue of recruiting and retaining women and URM STEM undergraduates has reached a point where it needs to be addressed by the highest institutional leadership, including trustees and regents, presidents, provosts, deans and department chairs.
- Yet, while, most (84%) believe the issue is important to their institution's chancellor/president, only one-third report their institutions have in place a comprehensive STEM diversity plan with specific retention and recruitment goals and an evaluation plan designed to assess progress.
- In fact, while the largest numbers of STEM department chairs assign an average grade of B and B-, respectively, to their institutions for retaining and graduating female and URM STEM students, more than one-third give their institution a C or below for retaining and graduating URM students.
 - Computer science and mathematics department chairs are significantly less likely to assign an A and significantly more likely to assign a C to their institutions for retaining and graduating female STEM students.

- The chairs acknowledge that their STEM departments face a range of challenges retaining and graduating URM STEM students, in particular. Chief among these challenges are URM students who don't have sufficient academic preparation to study STEM in college (21%).

They also cite as challenges:

- * problems recruiting/attracting URM candidates (16%);
 - * URM students who feel isolated from other students in STEM courses (15%); and,
 - * URM students who lack interest in the subjects (12%).
- For female STEM students, while the chairs report their departments face a variety of challenges, the most frequent response – 28% – is their departments faces no such challenges with retaining and graduating female STEM students. Strikingly, the most common challenges that exist for the STEM faculty with their female STEM undergraduates, are:
 - *the women's own lack of interest (18%); and,
 - *personal/family responsibilities (11 %).

STEM Department Chairs on Challenges Retaining and Graduating STEM Students

For all students, regardless of race, creed, color or aptitude, the biggest challenge is financial- helping them find the money to stay in school.

[For URM] Preparedness is a challenge... we do not control admissions. If they are not admitted to the college, we have no chance to retain them... it's an induction problem: students need to see students who look like themselves.

Female biology students too readily put their aspirations aside for family... there is lack of adequate advising in high school... providing a supportive environment when the vast majority of the students are male.

Underrepresentation and Enrollment of Female and URM Undergraduate STEM Students

Females have made greater enrollment strides in STEM undergraduate courses than URMs. While STEM enrollment trends are positive for both groups in both introductory and major/upper level STEM courses compared to those for majority students, URMs are still sorely underrepresented in both introductory and major/upper division STEM courses.

- In reporting enrollment trends for the past five years for female, URM and majority STEM undergraduates in both introductory and major/upper division courses, about half of the STEM department chairs say there has been no change in enrollment status for the three student groups.
- A significant number – more than one-third – report an increase in female (44%) and URM (35%) enrollment in introductory STEM courses compared to majority students (15%). A very small number report enrollment decreases for female and URM students (3% and 4%, respectively).
- A similar picture is painted by the chairs for enrollment in their major/upper division STEM courses. Almost half (45%) say female enrollment in these courses has increased over the last five years and nearly one-third (31%) say URM enrollment has increased, compared to only 15% for majority students. Again, a very small number report decreases for female (5%) and URM (4%) STEM undergraduates.
- However, most – eight-in-10 – STEM department chairs say URM students are underrepresented in both their STEM introductory and major/upper division courses. And they say only 16% of the STEM degrees their departments will grant this year will be to African-American, Hispanic and American Indians students, compared to the 83% of STEM degrees that will go to majority STEM students (70% Caucasian; 12% Asian).
- Less than half as many – roughly one-third – STEM department chairs say female students are underrepresented at both course levels.
 - Engineering and computer science department chairs report greater underrepresentation of females in introductory courses and, they, along with physical science department chairs report greater female underrepresentation in major/upper level courses.
 - Those from larger STEM departments report greater underrepresentation of females in both their introductory and major/upper level courses.
 - Despite enrollment gains for women, the STEM department chairs say their departments will grant more STEM degrees to males (58%) than females (42%) this year.

Preparedness and Skill Level of Undergraduate STEM Students

Female STEM undergraduates are most likely to be poised for STEM degree completion, while URM students are least likely.

- The largest number of STEM department chairs – just over eight-in-10 (82%) – view females to be the most adequately prepared academically when they enter college to complete studies and graduate with STEM degrees, followed by seven-in-10 (74%) who feel this way about majority students.
- URM students are the least prepared academically when they enter college to complete studies and graduate with STEM degrees, according to the STEM department chairs, with half (49%) saying they are not adequately prepared.
- More than nine-in-10 (93%) say their female students, given similar academic preparation, are more or as likely as their majority students to successfully graduate with STEM degrees.
 - Engineering department heads believe their female students are more likely to succeed.
- Fewer – six in 10 – say given similar academic preparation, their URM students are more or as likely to be successful in STEM as their majority students. One-third (33%) say their URM students are less likely to be successful, compared to only 5% who say this about their female students.

STEM undergraduates are considered prepared for the workforce.

- Most – eight-in-10 (81%) STEM department chairs are confident their undergraduate STEM students have the skills they need upon graduation to enter the STEM workforce. Only 16% believe the students will need additional training.

Pre-college STEM education should begin early and with a better curriculum.

- The vast majority of STEM department chairs (69%) concur that students should begin their STEM education foundation in elementary school, specifically kindergarten through 5th grade.
 - This is especially true among Caucasian department heads (71% Caucasian vs. 51% not Caucasian).
 - Twice as many female STEM department heads believe students should begin receiving STEM education foundation in pre-school (30% female vs. 14% male).
- Improving the STEM curriculum is the single most important thing the U.S. K-12 education system can do to better prepare *all* students to study STEM in college, say half (48%) of the STEM department chairs. Other recommendations include:
 - * improving/providing STEM career counseling/guidance (14%);
 - * improving STEM teacher training/preparation (13%); and,
 - * improving STEM methodology by teaching more critical thinking/problem solving and using less standardized assessments (11%).

Rigorous “weeding out” introductory STEM courses are seen as generally harmful with more impact on URM STEM undergraduates.

- The effect of rigorous STEM introductory courses that “weed out” students from STEM produced mixed feelings among the STEM department chairs. About half (46%) believe the rigorousness of these courses are generally harmful because they may drive away students with potential, while the remaining half is split between those who believe these rigorous courses are generally beneficial (29%) and those who don’t know or didn’t answer (25%).
 - Significantly more computer science chairs believe the “weeding out” introductory academic approach is harmful.
- While almost half believe the effects of introductory “weeding out” courses are harmful, six-in-10 (56%) STEM department chairs also think these courses have more of an effect on URM STEM students than they have on majority students. Only one-quarter (25%) said they have less of an effect on URMs than majority students and none said these courses have no effect.

Nearly – three-in-10 (27%) – also believe these courses have more of an effect on female STEM students. A majority (53%) say they have the same effect on female as majority STEM students.

- More female STEM department heads believe female STEM students are more affected by these “weeding out” course than majority students.
- Significantly more computer science chairs believe this approach has more of an effect on female students.

Yet, STEM department chairs see no reason to significantly change their introductory course methods.

- Despite acknowledging the negative impact rigorous introductory STEM courses have on URM STEM undergraduates, a majority (57%) do not see a need to significantly change their introductory course instructional methods in order to retain more STEM students, including women and URMs.
 - Agriculture and mathematics department heads are more likely to agree that there is no need for such change.
- Instead, a large majority (71%) believe that to retain more students, their departments should significantly increase the academic support they offer to students, including mentoring, tutoring, informal faculty engagement and professional networking opportunities.
 - And among those who believe their departments should significantly increase the academic support they offer to students, three-quarters (75%) do believe their department faculty has a responsibility to provide such increased student academic support.

[URM students] often are discouraged because the intro courses are challenging compared to their high school experience. This is not only true for URMs, but they seem to take this challenge as a sign they should do something else.

- STEM Department Chair

Recruitment and Retention of Female and URM Undergraduate STEM Students

Informal department-level STEM recruitment programs targeting female and URM students are more widespread than retention programs.

- While only one-third (33%) of the STEM department chairs polled report their institutions have formal diversity programs with specific recruitment and retention goals and assessment tools, the chairs say more informal diversity plans do exist at the nation's top research universities within different STEM departments.
- Two-thirds (64%) of the STEM department chairs report department-level recruitment programs for female and URM STEM students exist within their colleges/universities. Fewer – less than half (43%) – say similar programs for retention exist.
- Roughly one-third (36%) say their colleges/universities have informal department-level programs featuring both recruitment and retention approaches for female and URM STEM undergraduates.

Retention is an across the board issue. Most incoming students have a poor STEM background from high school... some do not like the amount of remedial work... many students are also non-traditional and have trouble balancing work, family and school.

- STEM Department Chair

Recruitment and retention programs have common key characteristics.

- A diverse spectrum of frequently-mentioned elements characterize department-level recruitment and retention programs, according to the STEM department chairs whose colleges/universities have such programs in place.
- Recruitment programs most often consist of:
 - ✓ Summer programs that involve field study and hands-on learning experiences (80%);
 - ✓ High school outreach programs that provide academic information and career counseling (77%)
 - ✓ Financial resources such as scholarships/paid internships (66%)
 - ✓ Outreach programs that have female/URM STEM undergraduates working with high school students on tutoring, mentoring and science fairs, etc. (58%)
 - ✓ Outreach programs that develop feeder systems of female/URM students directly to college (55%)

Recruitment is the critical issue... more funding is needed to support URM faculty who can be instrument in recruiting URMs... the biggest challenge is attracting URMs in the first place because of stereotypes about the population of people that are in STEM careers.

- STEM Department Chairs

- Retention programs most often consist of:
 - ✓ Faculty mentors (78%)
 - ✓ Academic support including study groups, tutors and other supplementary support (74%)
 - ✓ Peer support networks (74%)
 - ✓ Undergraduate research opportunities for juniors and seniors (73%)
 - ✓ Undergraduate research opportunities for freshmen and sophomore (62%)
 - ✓ Provision of adequate financial aid/support (60%)
 - ✓ Professional development activities for juniors and seniors that include participation in conferences, networking and research presentations (59%)
 - ✓ Undergraduate summer STEM programs targeting women and URM (51%)

Best retaining practice has been to get undergraduates involved in independent research or support research in faculty labs. Unfortunately we have more students who would like to do this that opportunities or faculty able to serve as advisors.

- STEM Department Chair

Recruitment and retention programs, while generally viewed as good, are less effective for URM STEM students than for female STEM students.

The problem is with recruitment... it is not as high as I would like it to be. URM students are not well prepared but the summer bridge programs and on-demand tutoring through the Office of Diversity help rectify the problem.

[For female students], most retention problems stem from two things: poor preparation in high school and poor first year college advising/orientation for success/survival.

- STEM Department Chairs

- Recruitment programs for URM undergraduate STEM students get an average grade of C+ from the STEM department chairs whose institutions have such department-level program in place. Similar programs for female STEM undergraduates fare better with an average grade of B-.
 - Department chairs are more likely to assign a C than an A to recruitment programs targeting both groups of students
 - Male department heads rate their female recruitment programs significantly higher than female department heads do.
 - Biology department heads are more likely to assign an A or B to their female recruitment programs.
- Department-level retention programs for both URM and female STEM students get an average grade of B-.
 - Again, department chairs are more likely to assign a C than an A to retention programs aimed at both groups.

Lack of funding/resources is the biggest barrier to research universities' adoption of STEM diversity recruitment and retention programs.

- More than one-quarter (28%) of the STEM department chairs whose institutions do not have department-level STEM diversity programs say lack of funding/resources is the most significant barrier to the adoption and implementation of such recruitment programs, while more than one-third (37%) say the funding issue is a barrier to putting retention programs in place.
- Lack of university leadership support (16% for both recruitment and retention programs) is cited as the second most significant barrier.

In the pursuit of their STEM undergraduate studies, URM students face different – and more – barriers than female students.

- Even though the STEM department chairs recognize that both their URM and female STEM students face various barriers in the pursuit of their STEM undergraduate studies, the largest proportion – 26 percent – say their female STEM undergraduates do not face any significant barriers.
- While limited quality pre-college science and math education is named by the chairs as a top barrier for URM STEM undergraduates (32%), fewer believe it is a barrier for women (12%).

- On the other hand, while a significant number of the chairs acknowledge that persistent stereotypes that say STEM isn't for girls/minorities is a barrier for their female STEM students, very few – almost none (3%) – acknowledge stereotyping is a problem for URMs.
 - Engineering and computer science department chairs are more likely to cite stereotypes as a barrier for their female students.
- Lack of STEM role models is acknowledged as a barrier facing both their URM (17%) and female (13%) STEM undergraduates.

STEM Department Chairs on Barriers for Women and URMs

We don't really know! We are in the midst of an exploratory campaign to learn the causes.

The challenge is more with recruiting women because there seems to be a bias against going into the STEM disciplines from earlier in their school career.

Overcoming the stereotype of white male dominance.

The misconception that engineering is a geek/loner profession, rather than the reality that it involves daily teamwork and interactions with people while making a major impact on the quality of lives of individuals, populations and the world.

African-Americans look at the all white campus and shake their heads.

Lack of female and URM faculty to serve as role models and mentors.

The numbers are always so small and they can feel isolated.

Making the students feel welcome and providing a nurturing environment... it is not just about having a bunch of people that look the same. It is about integrating them in ways that don't make them feel as second class students who are getting special treatment because they are not as good as others.

Discouragement of Female and URM Undergraduate STEM Students from STEM Studies and Careers

Discouragement still occurs today.

- Eight-in-10 (83%) of the department chairs believe that STEM faculty have a role in counseling students, who may not understand the commitment and ability it takes to succeed in a STEM major, to consider other fields of study.
- In fact, a large majority (58%) say such counseling is a common practice in their departments.
- Yet, few of the STEM department chairs, recognize that this type of counseling may be inappropriate to students. Only 21% say that their female and/or URM students have ever reported inappropriate discouragement either to them directly or to another faculty member.
(In last year's Bayer Facts survey, 4 in 10 of the female and URM chemists and chemical engineers working in the fields today said they had been inappropriately discouraged from pursuing STEM studies at some point in their lives, and the discouragement most often occurred in college by their professors.)
- While a large majority (68%) of STEM department chairs say their female and/or URM students have never reported such inappropriate discouragement to them or their faculty, they also say such discouragement of female and URM STEM students still does occur today. In fact, six-in-10 (59%) say such discouragement happens frequently (14%) or occasionally (45%), compared with 25% who say it rarely happens. Almost none – 2 percent – say such discouragement never occurs.
 - Eight-in-10 female department chairs believe this type of inappropriate discouragement occurs today frequently or occasionally compared to just over five-in-10 of the male department chairs.

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