



THE  
**STATE OF  
BLACK  
ARIZONA**

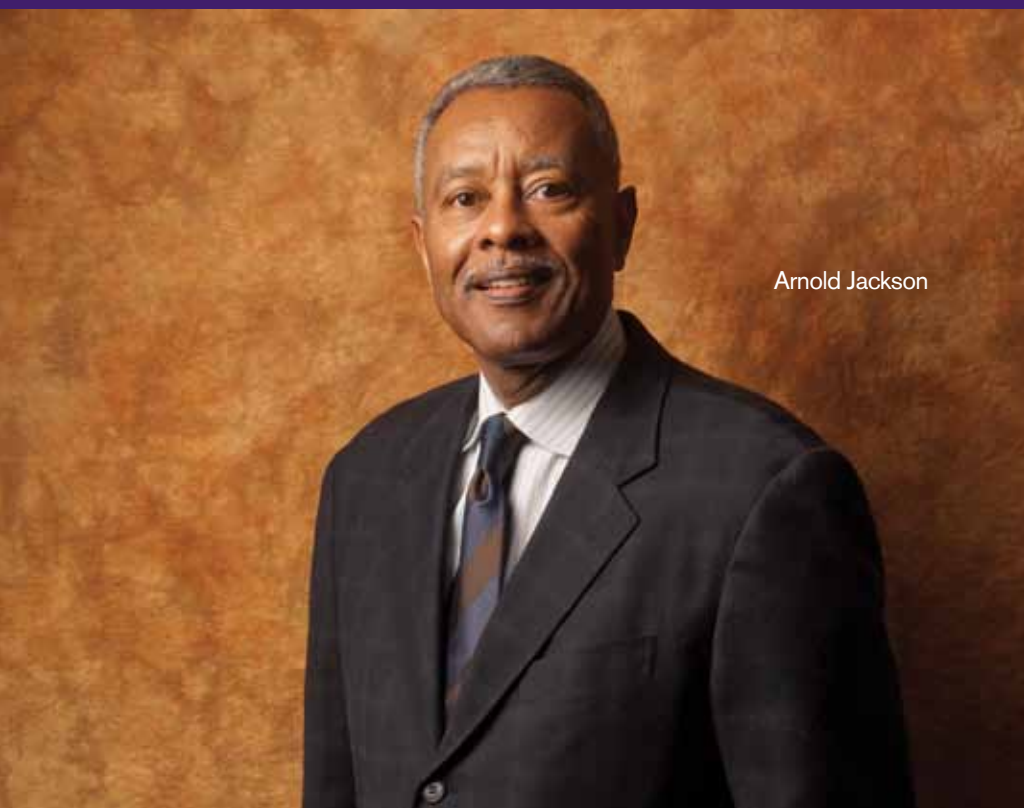
Volume 3



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At no other time in our nation's history has the value of an education focused on science, technology, engineering, and mathematics (STEM) been greater. The United States is simply not producing enough people with degrees or expertise in these quantitative and technical fields. This shortage of skilled people to perform thousands of unfilled jobs—and millions of STEM jobs forecasted to open in the next decade, even when unemployment is stubbornly high—is eroding the nation's economic health. African American students, irrespective of income level, are the least engaged in STEM fields. Unless this condition changes, another generation will lose the opportunity to move into the new world economy and an important talent pool will remain untapped, their potential squandered.

These facts are deeply troubling, yet they present enormous opportunity for African American students. STEM workers can earn higher wages than those in other fields (New York Times, *The Rising Value of a Science Degree*, October 20, 2011). **Reports show that African American males increased their annual incomes by 15% when they took at least one extra mathematics course in high school.** More math courses in middle and high school also increase the likelihood of young African Americans going to four-year universities and obtaining jobs that require quantitative skills (The Economist.com, 2009).

President Obama has made it a national *imperative* to dramatically improve student achievement in mathematics and science. His vision is to move U.S. students from the middle of the pack to the top on international benchmarks over the next decade, by challenging all Americans to significantly increase support for mathematics and science education. Arizona alone will demand nearly 154,000 new STEM jobs by 2018, a 16% increase over today; and 91% of those jobs will require postsecondary STEM-related education and training (Center on Education and the Workforce, Georgetown University, 2011).

In light of these data and with only 6% of African American people currently part of the STEM workforce, we face a very simple question:

***Do we have the will and the focus to support African American students and guide them in and through the STEM education pipeline so they can take advantage of the opportunities we know are awaiting them, here in Arizona and across the nation?***

Volume III of the *State of Black Arizona* addresses this question head-on. This report proposes a series of empirically-based recommendations and strategies to tap the considerable scientific and technical talent of Arizona's African American students, and to position them to take full advantage of the growing professional opportunities within their reach. The history of contributions to STEM fields from African American people over the centuries has been well established. There is no more important time than now to build on that rich legacy.

The Arizona Community Foundation, as part of its commitment to the African American community and through its *Black Philanthropy Initiative*, is honored to cosponsor, with Arizona State University and Arizona Public Services, this critically important third volume of the *State of Black Arizona*. As we have seen from the previous two volumes, supporting the exceptional work of the contributors to this report will help a new dialogue emerge around African American people and STEM. This dialogue will not only benefit our young people, but will also enable them to advance the quality of life for all of us in Arizona.

Sincerely,

Steven G. Seleznow  
President and Chief Executive Officer  
Arizona Community Foundation

# INTRODUCTION

Kimberly A. Scott, Ed. D.  
Associate Professor  
Arizona State University  
College of Liberal Arts and Science  
School of Social Transformation

Executive Editor  
State of Black Arizona

At around 4% of Arizona's statewide population, African Americans are often missing from the radar screen when it comes to discussions of equity, equality and/or disparity in our state. Without large numbers, attention to issues, achievements, and causes tend to be dismissed based on any and all of the following claims:

- 1) *Since there is no physical geographic community that hosts a majority-Black population, it is too difficult to implement meaningful strategies and efforts;*
- 2) *African Americans are relatively better educated and have a higher per capita income than their correlates in other geographic areas; thus, there is no need to examine disparity; and*
- 3) *There are larger race-ethnic minority groups who require more attention than African Americans.*

For some readers, the above assertions seem justified and rooted in truth. However, a more nuanced examination of each reveals a complex story of gaps and community advancement. In the following section of this *Introduction*, I consider each claim in turn to establish the importance of this third State of Black Arizona report.

***Claim 1: While there is no geographic area which touts 51% or more African American population, there are some schools in our state that do have a 51% or higher African American student population (n=4).*** Certainly, most African American students in kindergarten through grade 12 navigate educational institutions where they represent no more than 5%. Still, the question of how well our schools prepare African American students for the most lucrative and important 21st century careers—that is, careers in science, technology, engineering, and math (STEM)—remains highly relevant.

***Claim 2: Economic and/or educational attainment should not serve as the only barometers of a group's success.*** Assessment of how well a group is prospering should include the breadth and depth of afforded opportunities. Based on this approach to evaluation, results are grim. In the 8th Annual AP Report to the Nation, research indicates that among all race-ethnic minority groups in Arizona, African Americans are fairing the worst based on the number of Black students taking AP tests versus the number of Black students who could take the test. Unfortunately, this is in line with the report's national data which illustrate that although African American students have the greatest potential to enroll in AP classes (even higher than White students) they are the least likely to join such courses. What do these results mean in terms of preparing Arizona's Black high school students to enter the 21st century careers that will maintain our global edge—namely, STEM? How do these results inform our attitudes about Blacks entering STEM careers? Are there postsecondary efforts in our state that are addressing this issue? If yes, what are their success rates?

***Claim 3: To play in the Oppression Olympics—reifying one race-ethnic group's marginalization over others—is dangerous and counterproductive.*** All groups can learn from each other. For instance, after the first publication of the *State of Black Arizona (Volume I)* (see [stateofblackaz.org](http://stateofblackaz.org)), the *State of Latino Arizona* and *State of Asian Americans and Pacific Islanders in Arizona* emerged. Among all of these projects runs the common thread of presenting valuable and

Kim Scott

unprecedented data. Without this information, how can policy makers reach informed decisions? Which pathways should be followed, avoided, or destroyed to improve all of our communities, particularly in terms of poising more individuals from under-represented groups to become innovators in STEM professions?

The State of Black Arizona is a project committed to confronting the above claims. Our mission is to present accessible data that encourage change. In this third report, authors from Arizona and other states further our aim by focusing on the theme of science, technology, engineering, and math. As in the past, we engaged a cross-section of experts in answering the above questions.

The results include Arlisa Richardson's piece that examines how community colleges have widened the pipeline for African Americans to enter STEM majors; Roxanna Montoya-Gonzales and Terry Alford exploring the impact of parental involvement in STEM achievement; Jerlando Jackson et al 's article discussing the outcomes of a statewide survey assessing Black Arizonian's attitudes towards STEM; and Celestine Pea's analysis of federal grants. Lest we forget our shortcomings, this peer-reviewed report acknowledges one of the most important missing links, the arts. While the main focus of this volume is STEM, we are mindful that the arts play a critical role in innovation and the well-being of individuals. Thus, we conclude this report with a brief essay written by Council Person Coral Evans encouraging us to expand STEM to STEAM (science, technology, engineering, arts and mathematics).

In the end, we hope that this third volume inspires readers from all communities, disciplines, and geographic regions. Marian Wright Edelman eloquently stated, "We are living in a time of unbearable dissonance between promise and performance." This disparity is remarkably pronounced when examining STEM opportunities, achievement, and barriers for Arizona's Black population. Yet, this report remains hopeful. The authors both critique and make recommendations aimed at narrowing the growing gap between promise and performance. The time is ripe for this focus. As we progress deeper into the 21st century, STEM careers assume greater significance. Our nation and our state can only maintain its global presence by diversifying its workforce, methodologies, and directives. Our report symbolizes the State of Black Arizona's commitment to provide relevant information and insights to this effort.





Tamika Chiquito



Arisa Richardson



Crista Johnson



Mike Corner

# STEM Education: Arizona Community Colleges Striving for STEM Success

**Arlisa Richardson**  
**Physics Faculty**  
**Chandler-Gilbert Community College**

*Dr. Arlisa L. Richardson is a residential Physics faculty member at Chandler-Gilbert Community College. Arlisa earned a Bachelor of Science in Physics from Grambling State University, a Master's of Science in Physics from the University of Texas at Dallas and a Ph.D. in Curriculum and Instruction specializing in Science Education from Arizona State University.*

There are numerous reports, studies and data that show that the United States is not producing enough graduates in science, technology, engineering, and mathematics (STEM) to meet the growing demand for a high-technology skilled workforce (Blomberg, 2007; Bradley, 2011; Leach, 2010). To remain competitive in the global economy, the United States will have to prepare a workforce capable of competing in interdisciplinary fields that integrate STEM disciplines. In the 2010 State of the Union address, President Obama emphasized the need to improve U.S. educational outcomes in STEM fields to win the race for new jobs and build a robust economic future in competition with overseas businesses.

To meet future global workforce demands, all students must have a solid foundation in STEM. According to Leach (2010), who reported data on the challenges and opportunities for increasing the STEM pipeline, 67% of undergraduates in Singapore earned a degree in natural science or engineering, 50% in China, 47% in France, and 38% in South Korea. Only 15% of U.S. students earn these degrees.

According to the National Science Foundation's (2012) report on a 10-year trend, the percentage of African American students earning degrees in STEM from 1997 to 2006 remained about the same with a slight increase in master's degrees earned. Those earning bachelor's degrees averaged 8.2%, with a 0.6% increase; master's degrees averaged 6%, with a 1.6% increase, and doctorates averaged 2.6%, with a 0.2% increase. There is a slightly larger percentage of African American students who earned engineering technology degrees. In this field, bachelor's degrees averaged 9.6%; master's degrees averaged 8.8%, and doctorates averaged 3.3% (National Science Foundation, 2011). Increasing the low number of students in STEM fields is an ongoing challenge for the nation and it is especially interesting in Arizona where the African American population is approximately 4%.

## Stem in Early Education

The focus on improving STEM education needs to start early, prior to postsecondary education. Arizona has made progress toward improving STEM education for African American students in Arizona.

Change the Equation, a nonprofit, nonpartisan CEO-led initiative formed to address innovation and promote and improve STEM education, compiled a state-by-state analysis of mathematics and science education. According to its STEM data and key educational-attainment indicators for Arizona, the organization identified areas in need of improvement. These areas are aligned with the findings of a 2009 Minority Student Progress Report by the Arizona Minority Education Policy Analysis Center (AMEPAC; Morel-Seytoux, 2009). According to both reports, there are three key areas Arizona could focus on to boost student outcomes in STEM: **(a) raise the bar on student expectations, (b) narrow the achievement gap, and (c) improve college-preparation initiatives** (Change the Equation, 2011; Morel-Seytoux, 2009). The state's community colleges are actively involved in addressing STEM opportunities for underrepresented students. But is it enough?

## Raise the Bar on Student Expectations

The first area of focus is improving the mathematics-skills expectations by raising the bar on the state test to align with expectations for student performance on national and international assessments. The Arizona state test rates 74% of its fourth-grade students as proficient in mathematics, when only 28% of Arizona's fourth-grade students score proficient on the National Assessment of Education Progress (2009).

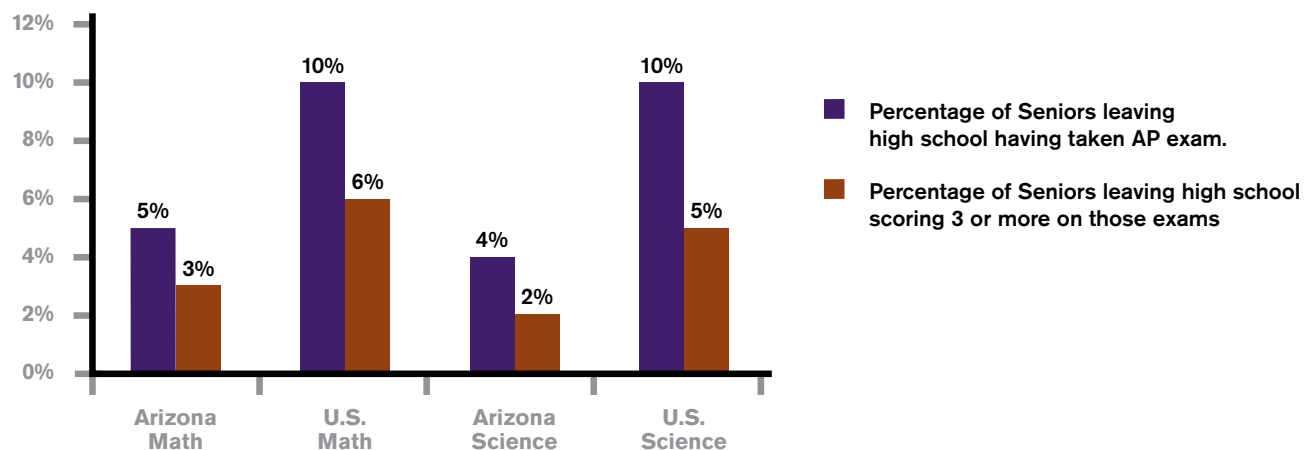
## Close the Achievement Gap

The achievement gap between students of color and Caucasian students seen across the nation is also an unfortunate trend in Arizona. The AMEPAC (Morel-Seytoux, 2009) report revealed that in Arizona, African American, Native American, and Hispanic students scored lower on all sections of the 2008 Arizona Instrument to Measure Standards test compared to Asian American and Caucasian students. This disparity was most notable in mathematics scores with only 47% of Native American, 56% of African American, and 56% of Hispanic students passing the section.

## College Preparation

College preparation includes advanced-placement (AP) courses, achievement on SAT/ACT examinations, and meeting basic course requirements for admission to a university. According to the Change the Equation report (2011), Arizona trails the nation in the percentage of high school students who take and succeed in AP examinations. Based on 2011 data for the 2010 class, Arizona is about half of a percentage point lower than the rest of the nation in the percentage of students enrolled in AP mathematics and AP science courses (see Figure 1). The AMEPAC (Morel-Seytoux, 2009) report data showed that 3% of the African American student population took the AP examination and 1.7% of these students scored 3 or higher.

Figure 1. Arizona Students College Preparation - AP Exam.



Source: The 7th Annual AP Report to the Nation, by College Board, 2011. Retrieved from [http://apreport.collegeboard.org/sites/default/files/downloads/pdfs/AP\\_RTN\\_2011.pdf](http://apreport.collegeboard.org/sites/default/files/downloads/pdfs/AP_RTN_2011.pdf)

The minimum high school-graduation requirements in Arizona do not meet the minimum requirements for admission to any of the Arizona universities, as shown in Table 1. The mathematics and social studies requirements are increased for 2012 graduates. For the class of 2013, the mathematics- and science-credit requirements are even higher, but still do not require the foreign-language minimum needed for Arizona university admission.

**Table 1. Arizona University Admission Requirements and High School Graduation Requirements**

University admission requirements	AZ minimum HS grad requirements	AZ minimum requirements 2012 graduates	AZ minimum requirements 2013 graduates
4 years of English	English 4 credits	English 4 credits	English 4 credits
4 years of Mathematics	Mathematics 2 credits	Mathematics 3 credits	Mathematics 4 credits
3 years of a laboratory science	Science 2 credits	Science 2 credits	Science 3 credits
2 years of a social science	Social Studies 2.5 credits	Social Studies 3 credits	Social Studies 3 credits
2 years of the <i>same</i> foreign language			
1 year of a fine art	CTE/Fine Art 1 credits	CTE/Fine Art 1 credits	CTE/Fine Art 1 credits
	Electives 8.5 credits	Electives 7 credits	Electives 7 credits

Source: High School Graduation Requirements, Arizona Department of Education, 2012. Retrieved from <http://www.azed.gov/state-board-education/high-school-graduation-requirements/>

This misalignment of high school-graduation requirements with university-admission requirements reflects a lower expectation of Arizona high school students and contributes to creating a larger achievement gap for Arizona students in general and African American Arizona students in particular.

Data shown in Table 2 indicate that from 1998 to 2006, the extent of progress for eligibility to 4-year public-university admission among high school students in Arizona varied greatly by race/ethnicity. Under existing admissions criteria, only 47.9% of Arizona's high school graduates are eligible for public-university admission, with Hispanic, African American, and American Indian students having the lowest eligibility rates of 35% and 26% respectively (Morel-Seytoux, 2009).

**Table 2. Eligibility Rates for Arizona University Admission by Ethnicity: 1989-2006**

	1989	1996	1998	2002	2006
<b>African American</b>	32.1%	40.50%	27.10%	31.10%	32.40%
<b>American Indian</b>	22.10%	40.40%	21.40%	20.90%	25.70%
<b>Asian American</b>	65.70%	73.90%	61.80%	65.90%	70.30%
<b>Hispanic</b>	31.20%	41.70%	29.00%	29.00%	35.30%
<b>White</b>	50.40%	61.00%	48.60%	52.10%	56.50%
<b>Total</b>	44.20%	55.30%	41.70%	43.90%	47.90%

Source: 2006 Arizona High School Eligibility Study, Arizona Board of Regents, 2007.

Retrieved from <https://azregents.asu.edu/boardbook/Board%20Agenda%20Books/2007-09-Meeting/Item-18-2007-09-.pdf>

It is essential that, before starting high school, all students are well-informed of academic requirements for university admission. Counselors should guide and encourage students to enroll in courses that would qualify them for university admission. The data trends summarized in Table 2, suggest that many Arizona high school graduates require additional coursework and preparation for university admission. Community colleges offer students an opportunity to meet the university requirements. Nationally, 44% of all U.S. undergraduates are community-college students, and 44% of African American students are community-college students (see Table 3).

**Table 3. Percentages of Community College Undergraduates (Fall 2008)**

All US undergraduates	44%
First-time freshman	43%
Native American	55%
Asian / Pacific Islander	45%
African American	44%
Hispanic	52%

Source: Fall Enrollment Survey, by American Association of Community Colleges, National Council for Higher Education, 2008. Retrieved from <http://www.aacc.nche.edu/AboutCC/Documents/FactSheet2011.pdf>

## Community Colleges and STEM

Community colleges offer an excellent opportunity to fill academic gaps in STEM courses and prepare students for university transfer, or offer advanced high school students an opportunity to take college courses while still in high school. Community colleges are a vital part of higher education because they serve almost half the undergraduate students in the United States and close to half of all underrepresented students (Estrella Mountain Community College, 2001). They also provide open access to postsecondary education by preparing students for transfer to 4-year institutions and offer workforce development and skills training. Community Colleges are uniquely situated to offer educational solutions by providing STEM-related programs to middle and high school students, as well as delivering postsecondary instruction emphasizing STEM coursework.

In general, Community Colleges are student focused and learner centered, with an overall goal to meet the academic needs of all students. Studies have shown that the academic experience should build self-efficacy through positive learning experiences, role models, and supportive persuasion, while teaching solid content and building critical-thinking skills. Leggon and Pearson (2006) summarized the effectiveness of programs designed to broaden the participation of underrepresented minorities in STEM. The report identified what works and found that the most effective programs provided holistic support that included role models and small study groups, and targeted academic support; such support created an overall sense of community. The inherent characteristics of community colleges—small classes, providing more attention to individual student needs, outreach, academic support resources, and partnerships with the K–12 community— create an ideal learning environment to support student success. These characteristics are aligned with elements of learning environments that support African American student success in STEM as identified at the University of Maryland Baltimore County (UMBC). The University of Maryland Baltimore County has created a nationally-recognized learning environment that ensures the success of all students, particularly African American students in STEM (PKAL, 2004).

## Arizona Community Colleges

There are currently 11 2-year public community college districts in Arizona. In total there are 20 community colleges in the state, and 10 of those are part of the Maricopa County Community College district. In 2009, African American students made up 5.28% of the total enrollment in Arizona 2-year colleges (see Table 4).

In fall 2007, African American students made up 5.2% of community college enrollment. In fall 2009, this percentage rose slightly to 5.3%. Between fall 2008 and fall 2009, African American people comprised 4% of Arizona's total population. There is an overrepresentation of African American students in Arizona's community colleges (Morel-Seytoux, 2009).

**Table 4. African American Enrollment in Arizona's Public 2-Year Degree Granting Institutions**

	Percentage of African American enrollees: 2009	Percentage of African American enrollees: 2007	Percentage of African American people in Arizona: 2007 & 2009
Arizona 2-Year Colleges (Community Colleges)	5.28%	5.20%	4%

Source: Minority Student Progress Report, Arizona Minority Education Policy Analysis Center, 2009.

Retrieved from <http://www.azhighered.gov/AMEPAC/09%20Minority%20Report%20with%20cover%20040110.pdf>.

The number of STEM associate's degrees and related certificates earned by African American students in Arizona's community colleges, shown in Table 5, has increased from 5.8% in 2000–2001 to 13% in 2008–2009. The Arizona community college with the highest number of African American students with STEM-related degrees and certificates is Cochise Community College, followed by Maricopa Community Colleges, Rio Salado, Phoenix College, Glendale Community College, and Estrella Mountain Community College.

**Table 5. African American STEM Completers in Arizona Community Colleges**

	2008-2009	2000-2001
Arizona Western College	2	0
Central Arizona College	3	6
Chandler/Gilbert Community College	1	4
Cochise College	117	7
Eastern Arizona College	1	0
Estrella Mountain Community College	10	9
GateWay Community College	4	12
Glendale Community College	12	8
Mesa Community College	4	2
Paradise Valley Community College	1	1
Phoenix College	15	2
Pima Community College	2	14
Rio Salado College	35	0
Scottsdale Community College	2	0
South Mountain Community College	3	3

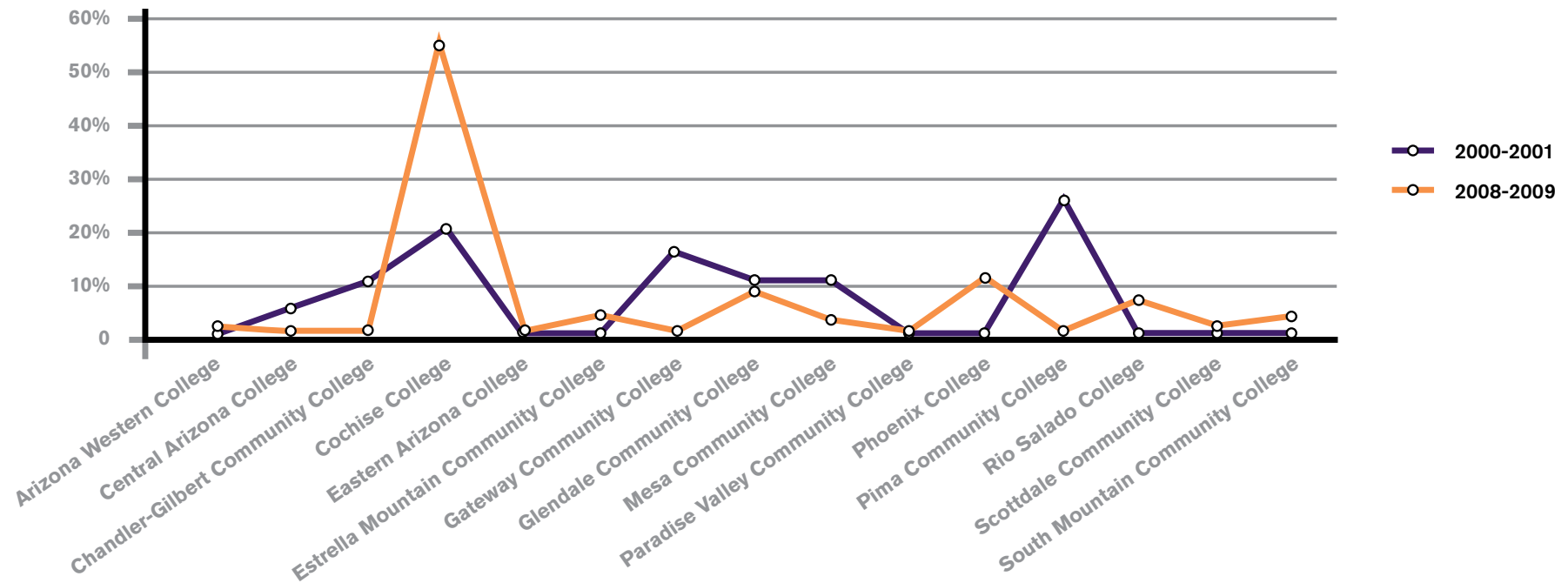
Source: National Center for Education Statistics, Integrated Postsecondary Education Data System, 2011, data retrieved from <http://nces.ed.gov/ipeds/>

The reason Cochise Community College has the highest rate of African American students completing STEM associate's degrees and certificates can possibly be attributed to the fact that Cochise Community College is a Servicemembers Opportunity College with an education center at the U.S. Army post, Fort Huachuca, where service members have easy access to classes and academic resources. As noted on the college's website (2011):

Cochise Community College recognizes the GED high school equivalency certificate/diploma, recognizes learning gained from specialized training and experience in the military services, establishes competency by nationally recognized means, maintains flexible transfer-of-credits policy for the mobile, active-duty or retired servicemember, conducts a timely evaluation of the educational records and relevant experiences of servicemembers and completes a student agreement or degree completion plan for all degree-seeking servicemembers. (Cochise, 2011)

According to the U.S. Department of Defense in 2007, African American people made up 21% of Army service members. In addition, Cochise College's main campus is located in the surrounding city of Sierra Vista where African American people comprise approximately 10% of the population. According to 2009 NCES data, from 2000–2001 to 2008–2009, there was an overall increase in the percentage of associate's degrees earned by African American students in Arizona community colleges.

Figure 2. Percentage of STEM associates earned by African Americans in Arizona community colleges



Source: National Center for Education Statistics, Integrated Postsecondary Education Data System, 2011, data retrieved from <http://nces.ed.gov/ipeds/>.

## Maricopa County Community College District

The Maricopa County Community College District is one of the largest community college districts in the United States. It serves over 250,000 students by providing affordable, quality educational opportunities through its 10 community colleges, two skill centers, and numerous education centers (Glasper & Ramakrishna, 2009).

Many community colleges in the Maricopa County district are addressing the need to improve STEM education and increase the number of students pursuing STEM fields. A variety of STEM efforts, partnerships, and enrichment and outreach programs in Maricopa County Community Colleges are providing students in traditional high school programs with added instructional content and encouragement in STEM areas. In addition, there are initiatives in place to encourage and support students at community colleges in the STEM fields. These programs and initiatives support student success in STEM by creating a seamless learning experience for students, and providing a rich opportunity to address STEM education challenges.

## Achieving a College Education (ACE) program

All 10 of the Maricopa County Community Colleges have an Achieving a College Education (ACE) program, providing high school students with an opportunity to complete college courses while still in high school. According to Maricopa Community College (2011), “The ACE program is a nationally recognized program that targets students who may not consider going to college and attaining a baccalaureate degree to be an achievable goal.” Through the program, high school juniors and seniors can earn up to 24 transferable college credits.

In eight of the 10 colleges, the ACE programs focus on general-studies college courses; however, Estrella Mountain Community College’s ACE program targets students who are interested in STEM fields and requires that the ACE student complete a specific number of college courses in mathematics and/or science. Gateway College’s ACE program is structured on specific career tracks in one of the following fields: health science, business, design technology, and transfer/social work track (ACE; Maricopa Community College, 2011).

The Maricopa ACE program serves more than 89 high schools, and from 1988 to 2011, ACE served more than 15,755 students. Data in Tables 7 shows that 11% of ACE students are African American and 82% of ACE African American students complete the ACE program and go on to college (ACE; Maricopa Community College, 2011).

**Table 7. ACE Student Demographics and ACE Students who go on to College**

ACE student demographics		ACE students who can go to college	
Hispanic	57%	Asian, Pacific Islander	87%
White, non-Hispanic	20%	African American	82%
African American	11%	Other	81%
Asian, Pacific Islander	5%	White, non-Hispanic	77%
not reported	3%	American Indian	76%
Other	2%	not reported	76%
American Indian	2%	Hispanic	75%

Source: 2009 Progress Report on ACE, by Maricopa Achieving a College Education, 2009.  
Retrieved from <http://www.maricopa.edu/studentaffairs/ACE/ACE%20Progress%20Report%202009.pdf>

## STEM-Related Programs at Maricopa Community Colleges

In addition to the ACE program, colleges in the Maricopa County Community College District offer a range of grant-funded initiatives that offer direct academic instruction in STEM, K–12 STEM-related outreach and enrichment programs, STEM professional-growth opportunities, and curriculum development and improvement. A summary of the Maricopa Community Colleges grant-funded programs are outlined in the following pages and summarized in Tables 8–11. This summary is based on data received from the Maricopa Community College District Grants office in July 2011. The programs are listed in the following categories: Student Success in STEM, Pedagogical Enhancement, High School Outreach, and Workforce Development.

## Student Success in STEM

The Student Success programs focus on recruitment, retention, and transfer of students in STEM. In general, the initiatives aim to increase student retention; target underrepresented student populations in STEM; and support STEM degree attainment leading to 4-year university transfer through scholarships, additional academic support resources, mentors, career-exploration options, and internships. Listed in Table 8 are projects at South Mountain Community College, Chandler-Gilbert Community College, Estrella Mountain Community College, and Phoenix College.

*Table 8. STEM Student Success Programs at Maricopa Community Colleges*

Project title	Funding source	College	Project Summary
Interactive BIO 181, 182 & 205 Study Group	National Science Foundation	SMCC/Arizona State University – WASEO	The purpose of the BIO undergraduate peer-study groups is to increase student understanding of fundamental biological concepts and to provide students opportunities to apply these concepts in real-life situations. Another goal of the study session is to help students recognize, develop, and put into practice active learning, critical-thinking study skills, and nontraditional study methods.
High-Tech Transfer Program Scholars	National Science Foundation	CGCC	The goal is to provide specialized educational opportunities and services for full-time financial-aid-eligible students with majors or program interests pursuing degrees in the fields of science, engineering, and computer-science engineering, particularly for those traditionally underrepresented in these fields: Hispanic, African American, Native American, female, persons with disabilities, and other students.
Buliding STEM Transfer Success – A Community College Cohort Approach	National Science Foundation	EMCC	This project will expand STEM opportunities to underprepared and nontraditional students by encouraging students interested in STEM areas, but who lack academic preparedness, providing student cohorts with faculty mentors, engaging students in a peer-mentoring component, and providing students with academic support through the “Math Emporium.”
The Academic Scholars Program	National Science Foundation	PC	The goal of the Program is to recruit academically talented but financially disadvantaged students each semester into STEM disciplines while providing a solid support system to ensure success through degree completion and transfer to a 4-year institution.

Source: Maricopa Community College District, District Grants Development and Management Department, June, 2011, C. Hale

## Pedagogical Enhancement

Pedagogical-enhancement programs include activities that involve curriculum development/enhancement of STEM courses, integration of student-research opportunities, STEM workshops for K–12 teachers and community college faculty, improved classroom/laboratory equipment, dissemination of information, and professional information/data exchange). The projects summarized in Table 9 include initiatives at the District Office, Mesa Community College and Rio Salado Community College.

**Table 9. STEM Pedagogical Enhancement Programs at Maricopa Community Colleges**

<b>Project title</b>	<b>Funding source</b>	<b>College</b>	<b>Project Summary</b>
<b>NAU Noyce Fellows Program</b>	<b>National Science Foundation</b>	<b>MCC/Northern Arizona University</b>	The aim of this program is to increase the number of students majoring in science and mathematics education to increase the number of K–12 science and mathematics teachers.
<b>Developing the Digital Technologist for the New Millenium</b>	<b>National Science Foundation</b>	<b>CGCC/University of New Mexico</b>	This project is designed to develop instructional curriculum for community college instructors and to teach two workshops per year.
<b>Nanotechnology Applications and Career Knowledge Education Center</b>	<b>National Science Foundation</b>	<b>District Office/ Pennsylvania State University</b>	MATEC will have a leadership role in curriculum development and dissemination activities for the national advanced technological education NACK center.
<b>Collaborative Project: GARNET II</b>	<b>National Science Foundation</b>	<b>MCC</b>	This project is an effort to better understand how student attitudes and motivations affect their approach to learning geology in introductory geology classes.
<b>Collaborative Research: Community College Students Conduct Field Research</b>	<b>National Science Foundation</b>	<b>MCC</b>	The goal of this collaborative project with Arizona State University and University of California, Davis is to develop and implement modular instruction that leverages the intrinsic motivation of learners toward cultural heritage through their execution of field research.
<b>ATE Impact 2011</b>	<b>National Science Foundation</b>	<b>District Office</b>	For the development, dissemination, and maintenance of an interactive website and annual print materials. Collaboration with the 37 Advanced Technological Education centers.
<b>Science and Math in Arizona Rural Teaching Fellows Planning</b>	<b>National Science Foundation</b>	<b>RSCC</b>	Develop an articulated teacher preparation and master's degree program for STEM professionals seeking to enter careers in science and mathematics teaching in rural Arizona communities.

Source: Maricopa Community College District, District Grants Development and Management Department, June, 2011, C. Hale

## High School Outreach

The High School Outreach program offers high school students an opportunity to learn more about specific STEM fields through related enrichment courses or workshops, with a goal of preparing students for postsecondary education in STEM.

**Table 10. STEM High School Outreach Programs at Maricopa Community Colleges**

<b>Expanded Undergraduate Bioscience Engagement Track Year 3 of 3</b>	<b>U.S. Department of Agriculture</b>	<b>SMCC</b>	The purpose is to increase the number of students, especially minority and underrepresented students, entering training, education, and careers in bioscience. The project targets high school students and provide dual enrollment bioscience courses through the community college.
<b>Bioscience Summer Camp 2011</b>	<b>U.S. Department of Education</b>	<b>SMCC/Western Tech Prep Consortium</b>	The goal of the project is to collaborate with the Western Maricopa County Tech Prep Consortium to conduct a 5-week program, Biosciences Workshop-Basic, to encourage students to explore careers in the biosciences and to attend one of the bioscience programs offered through MCCC.

Source: Maricopa Community College District, District Grants Development and Management Department, June, 2011, C. Hale .

## Workforce Development

The Workforce Development initiative provides faculty members an opportunity to learn more about specific STEM-industry workforce needs through externship opportunities. This allows faculty members to experience first hand the needs of a particular industry and align their course curricula with industry needs to ensure students are adequately prepared to meet the demands of a specific STEM workforce.

**Table 11. STEM workforce development program at Maricopa Community Colleges**

<b>High Tech Workforce Initiative 2.0 – Externship Driven Talent Development</b>	<b>National Science Foundation</b>	<b>District Office</b>	The High Tech Workforce Initiative—Externship Driven Talent Development focuses on preparing the workforce that will enable the Greater Phoenix region to grow and achieve competitive advantage in the high-technology industries that policymakers and planners have targeted as the region’s strategic drivers of economic development.
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Source: Maricopa Community College District, District Grants Development and Management Department, June, 2011, C. Hale /

In closing, Arizona community colleges play a vital role in making postsecondary STEM education accessible to all students. Through partnerships with K–12 and 4-year universities, community colleges are filling academic gaps and creating seamless transitions from high school to the community college and from the community college to 4-year universities or the workplace. In Arizona there are very few community college initiatives specifically targeting African American students. However, there are initiatives targeting underrepresented groups to pursue STEM fields. Arizona’s community colleges engage in best practices to support recruitment, retention, student learning, and successful completion, making them ideally situated to encourage and prepare African American students in STEM fields. The communities served by community colleges are challenged to utilize and maximize the STEM educational opportunities available for students, educators and the workforce. Yet, the question remains whether these efforts of Arizona’s community colleges are enough.

***“A special thanks to the State of Black Arizona for highlighting such an important issue that is often overlooked. Sincere appreciation to the Maricopa County Community College District Grants Office, Hui Zou at Arizona State University, and the Estrella Mountain Community College Office of Institutional Research for providing data for this paper. Thanks to the State of Black Arizona editorial team for the invaluable feedback and suggestions.”***

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Roxanna Montoya-Gonzales



Terry Alford

# Parental and Community Support for STEM Education

**Roxanna Montoya-Gonzales**

**LeRoy Eyring Center for Solid State Science, College of Liberal Arts  
Arizona State University, Tempe, AZ 85287**

*Roxanna Montoya-Gonzales is an Arizona educator currently specializing in STEM based education. She works with research scientists from various disciplines, industry professionals, and partners with numerous school districts and organizations in the Phoenix Metro area*

**Terry L. Alford**

**School for Engineering of Matter, Transport, and Energy  
Arizona State University, Tempe, AZ 85287**

*Dr. Terry Alford holds the rank of professor in the School of Engineering at Arizona State University. He is currently the chair of the Materials Science and Engineering Graduate Program and has authored or coauthored over 230 archival publications, four patents, and two books.*

Many studies show a decrease in the number of Black students choosing science, technology, education, and mathematics (STEM) majors and careers over the last 10 years. The findings in this study demonstrate that parents, educational institutions, and other community organizations can work together to have a significant impact on student achievement in all areas of study including STEM subjects. The literature review for this study supports the notion that both parental involvement and community support are essential in the development of a child's education and his academic success. In addition, the study explores the importance of American public schools encouraging parental involvement and community support in a children's education by design. Data indicate that parental involvement and community support have the power to improve a student's performance in school, regardless of factors such as socioeconomic background or ethnicity. A survey study was conducted to investigate how parental and/or community organizations have influenced Black STEM professionals in Arizona in their decision to choose STEM majors in college and subsequently pursue STEM based careers. The majority of respondents experienced parental and/or community engagement involvement in their K-12 academic careers. According to our findings, Arizona schools could benefit from collaborative partnerships to considerably improve our schools and boost our global presence with an increased number of STEM professionals.

Of the issues concerning the education of Arizona's youth, the declining interest in science, technology, engineering, and mathematics (STEM) related subjects among African American students is one that warrants closer examination. Many investigations, including a 2009 study by the National Center for Education Statistics (2009), show a decrease in the number of African American students choosing STEM majors and careers over the last 10 years.

The purpose of this essay is to examine the educational and developmental advantages of strong parental involvement and community partnerships in and around schools. This essay also examines how parents and/or community organizations have influenced African American STEM professionals in Arizona in their decision to choose STEM majors in college and STEM-based careers. Investigations of this sort are significant because they document the fact that both parental involvement and community support in education are essential to student academic success, during the K-12 school years.

A considerable portion of a child's intellectual and behavioral development is facilitated by educational experiences, community interaction, and family environment. Since this is the case, it is critical to invest time and funding into projects that promote the education and well-being of children and families (Kirshbaum, 1998). The creation of a STEM pipeline for example, from grade school to graduate school, might be the key to increasing interest in STEM majors and professions among all Arizona students. Successful academic pipelines require dedication from schools, support from community organizations, and parental involvement.

This study, along with continued research and evaluation of the positive effects parental involvement and strong community support have on the education and well-being of children, may be used to encourage the development of public programs and to increase the number of parents and community organizations that participate and support their neighborhood schools. Involvement of community organizations and parental support for schools and students has the power to help students develop a strong desire to do well academically and to seek postsecondary education.

## **The Private School Model for Parental and Community Involvement in Schools**

Private schools have successfully integrated their surrounding community organizations to create enrichment programs that help support student learning. This study defines private schools as K–12 schools not organized by local or federal government. Of all private schools, Catholic schools, in particular, have been recognized for helping to lower the student dropout rate, in part because of the strong parental involvement and community support they receive (Boffetti, 2001).

A 1982 study of private schools showed that Catholic school parents were more likely than public school parents to attend school functions such as parent–teacher conferences. Catholic school parents were also almost twice as likely as public school parents to volunteer to help with school fundraising or school projects (Kahlenberg, 2001). This study defines parental involvement as the parental contribution to a child’s education through participation in programs or activities that help increase student achievement and involves, but is not limited to, reading with young children daily, helping students with homework or obtaining a tutor, attending school functions, volunteering in the school regularly or with school special events, encouraging students through their academic careers, and helping students develop a career path by regularly promoting higher education.

With the realization that parental involvement and support from the community is needed to help students achieve greater academic success, the U.S. Department of Education offers parents a free publication to promote parental involvement in their children’s education. One of the goals of this publication, *Parent Power: Build the Bridge to Success*, is to provide the necessary basic knowledge to encourage all parents to “take responsibility for their child’s success” (U.S. Department of Education, 2010).

The publication provides ideas for parents on how to encourage and be involved in their child’s education from preschool to high school and was created for parents who feel uncomfortable in their child’s school, may not have the time, or may otherwise feel unable to support their child academically. Parents can effectively use this resource to equip their family with new ideas on how to dedicate time and energy into becoming more supportive of and directly involved in the education of their children.

To that end, Joseph Dulin introduced the National African American Parent Involvement Day in 1995. The annual event is held on the second Monday in February. The endeavor is an effort to get parents involved in their child’s education and to begin to close the educational “achievement gap” for African American students (NAAPID, 2011).

## **School Report Card and Mission Statement Study**

To help public schools increase the academic performance of their students, comprehensive school-reform (CSR) models were developed in the late 1990s to update and redefine school organization (Coleman, et al., 1997). Several schools turned to community organizations such as universities and educational centers

for help in the development and implementation of their CSR models (Borman, Hewes, Overman & Brown, Hewes, Overman, 2002). Among the goals of any CSR model is to provide measures for the development of initiatives that help schools increase their level of parental involvement. To determine the effectiveness of Arizona schools in their inclusion of parental involvement, we conducted a study of 12 schools in the Phoenix metropolitan area. Both academic goals and mission statements were examined in this study.

Twelve Arizona Academic Report Cards were chosen for 12 different schools, based on whether they received a rating of excelling or underperforming; six of each were randomly selected. Provisions were taken to ensure that the selected schools represented areas from varying socioeconomic levels. The excelling and underperforming categories were chosen to determine if excelling schools differed in their views of parental involvement and student achievement from underperforming schools.

Studies such as this are noteworthy because, since the 1990s, U.S. policy has required schools to reorganize, either independently or through the hiring of professional organizations. Schools have also been encouraged to rethink their approaches to education and parental involvement. When schools go through the process of reorganization, the mission statement is often one of the first items to change. The intention is to create a meaningful guide for each school that provides a focus on the objectives the school aspires to achieve (Bafile, 2001).

School report cards provide data on data on academic performance, school rating, enrollment, safety incidents, a shared-responsibility section, as well as a school's academic goals and mission statement. These reports may be reviewed at any time by any state or federal agency, as well as by parents and other members of the community.

Performance levels for schools in the state of Arizona are based on a fixed measurement scale with detailed descriptions that distinguish performances of different quality (Arizona Department of Education, 2005). The achievement categories by which schools are evaluated fall into five performance levels: failing, underperforming, performing, high performing, and excelling. A school is considered underperforming if it fails to meet both state performance standards and progress goals. A school is rated as excelling when it scores significantly above state performance goals and when a significant number of students have exceeded the standard on the Arizona Instrument to Measure Standards test.

According to U.S. policy, all public schools are required to develop ways of getting parents more involved in their child's education and improving the school (NCLB, 2005). Of the six schools identified in this study as excelling, all stressed the importance of parental involvement beyond the home.

**The comments that refer to parental involvement appear below:**

- Parents are partners in the teaching and learning experience.
- [Our School] is committed to academic excellence. This is accomplished through high expectations, a caring learning environment, consistent discipline and the partnership among students, staff and parents.
- Parent volunteers are integral to continued student success.
- We value our partnerships with parents and guardians in meeting students' needs and we encourage parent participation.
- Learning is a partnership of parents, students, and staff.
- Parents volunteer in record numbers in our school and we know that their presence in our classrooms has a positive effect on student learning. Our parent-teacher organization is very active, providing many opportunities for involvement.

Each example of the excelling school's mission statement described the parental role as one that extends beyond the home and reaches directly into the school. The mission statement or academic goals for each school acknowledged parental involvement as a tool for helping students reach academic success. Of the schools identified as underperforming, parental involvement focused primarily, though not solely, on using parental support in the enforcement of school rules and in requiring parents to provide their children with basic needs. **The parent responsibility passages, as expressed in the school report cards for each of five Underperforming schools, appear below:**

- Parents provide their children the means of arriving to school on a daily basis. It is their responsibility to support the educational mission. Parents are responsible for clothing their children in the district's adopted uniform dress code.
- Parents are responsible to have students in attendance; provide a study place and study time at home and become a part of the team accountable for the success of their child.
- Read with children 30 minutes per day. Make sure children are well rested and properly fed. Involve the children in the responsibilities in the home. Provide opportunities for children to read and write. Use community resources when needed. Network with other parents. Attend School functions. Drop off and pick up students on time. Participate in parent teacher conferences and communicate with the school.
- Parents are expected to attend conferences, school activities, read newsletters and other important material brought home by their child, to review homework daily, encourage good attendance, and ensure that students arrive and leave school on time.
- Parents become a part of school by volunteering, reading to their children; assisting students with homework; maintaining a quiet place to do homework; attending parent conferences; serving on the booster club or SCC [School Community Council] and the Family Support Team.

Goals for parents in each of the underperforming school case studies focus on providing children with basic needs, and they hold parents to essential responsibilities such as feeding their children or dropping them off at school on time. These statements indicate the possibility that, at the time these goals were written, these schools and their students were not receiving the proper support from parents in their community. Is it possible that in these cases, lack of parental support may be a contributing factor to these schools' underperforming categorization?

In contrast, the final school in the underperforming category was unique from the others in that it did not specify any academic goals. Nothing in this public charter school's report card outlined the school's plan for improving its underperforming academic scores.

Each of the eleven other schools, regardless of performance level, set distinct academic goals. The academic goals for the Underperforming schools, with the noted exception of the public charter school, all focused on academic growth. Goals for the Excelling schools all allowed for the addition of enrichment programs and community involvement to aid in the overall learning experience of their students. They each included such goals as "We will continue to encourage the acquisition of character and life-long learning skills in such areas as respect, responsibility, perseverance, problem solving and cooperation" and "We will continue to broaden the opportunities for community service and involvement as students develop leadership skills through their participation in a wide range of community and diversity awareness programs."

Excelling schools were directly compared to one another, as were underperforming schools. Similarities in the mission statements, shared responsibilities, and academic goals for excelling schools included similar views on parental involvement. The excelling schools varied in location throughout the Phoenix metropolitan area. Socioeconomic levels among the individual excelling schools varied from above the Arizona median income level to well below. Although several studies have shown that economic status is a key factor in school quality (Kahlenberg, 2001), parental involvement continues to be listed as the most important factor in student academic achievement (U.S. Department of Education, 2010).

Traditionally, middle-class schools have consistently performed better than schools in lower-class neighborhoods, in part because parents in middle-class neighborhoods are more readily available to volunteer at school and have the funding to make monetary donations to their schools (Kahlenberg, 2006). However, this connection to economic status was not evident in our study, as shown by the diverse range of socioeconomic level of families and communities involved in the excelling schools. Our findings support the notion that student academic performance is determined by factors that strongly outweigh the socioeconomic levels of families. In addition, the size of the student body was not a factor in this study, as each of the six excelling schools had a comparable counterpart in the underperforming category.

After the comparison of mission statements and goals from schools in the same performance category, the school information was then compared between the excelling and underperforming categories. Three significant differences emerged in reviewing these school report cards.

The first difference is the role of parents as presented in each school's academic report card. Four of the six underperforming schools focused primarily on requesting basic needs for their students from parents, including making sure children are fed and properly dressed for the weather. Each of the excelling schools described the roles of parents at their schools as "partners" and "integral to continued student success."

Second, each of the excelling schools expanded its academic goals section to include specific objectives that support student academic performance and extend knowledge through enrichment programs. The academic goals of the underperforming schools differed in that five of the six schools defined only academic goals while the sixth underperforming school (public charter and noted exception) did not specifically address student needs in reading, writing, and mathematics.

Third, five of the six underperforming schools were very explicit in their requests to parents. Their needs were made very clear, citing specific responsibilities for parents while the excelling schools had very broad responsibilities for parents that focused on the home and school connection without citing specific responsibilities. This was a significant finding as it may indicate that schools in the underperforming category have specific needs that have not yet been met.

School report cards provide a public snapshot of any given school's performance level. Though it is difficult to gain conclusive evidence to prove, for example, that there is a definite connection between the parental involvement in excelling schools and the academic performance of their students, school report cards do provide insight into each school's structure and academic objectives, as well as proof of their academic accomplishments.

Findings in this study were consistent: schools where students perform well academically also have strong parental participation. Each of the excelling schools reported a high percentage of parental participation, whereas the lower performing schools repeatedly acknowledged a lower level of parental participation.

## Community Support for Education

The welfare and educational development of children are among the concerns that have guided the current changes in education reform. Community support involves nonprofit organizations, schools, universities, and members of the community working together to develop programs that focus on a child's overall education. **In short, it takes an entire community to educate children and to secure their well-being.**

Studies have provided significant evidence to show that both community support and parental involvement have the power to benefit all children, regardless of factors such as race or socioeconomic background (Berger, 2000). As a result of this knowledge, federal agencies, such as the National Science Foundation (NSF), promote community partnerships among schools, universities, and other community organizations. NSF's strategic plan for fiscal years 2006 to 2011 requires all submitted research proposals to include a "broader impact" component. According to the NSF, this component is put into place to teach, train, and provide the public with a learning experience that, in part, promotes the progress and understanding of science to "empower the nation through discovery and innovation" (NSF, 2011).

Since 1984, The Arizona Council of Black Engineers and Scientists (ACBES), at Arizona State University (ASU) has hosted an annual summer computer camp. Each year, approximately 55 middle school students from schools in the Phoenix metropolitan area attend this summer camp for 5 consecutive Saturdays. During this time, students learn computer programming and problem solving methods, among other skills. What sets this camp apart is that it writes parents directly into the curriculum.

As part of this community outreach program, parents are offered the opportunity to learn ways of supporting their child's academic interests, to help their child prepare for college, and to learn about financial aid opportunities. Supplemental changes to educational programs offered by community organizations, such as ACBES and other ASU programs, demonstrate the growing understanding of the fundamental need to include parents in the academic support and development of their children.

The educational and developmental needs of children require a diverse mix of professional skills and collaborative efforts. For years educators have recognized the importance of having the support of the community they serve and of the need to work with parents as partners in helping their children achieve all that they can in their academic careers (Dodd & Konzal, 2002). Collaborative efforts in Arizona began to gain momentum with the funding provided by the U.S. Department of Education in support of the idea that the well-being of individuals in a society is directly related to the well-being of families in society (U.S. Department of Education, 1997.)

The notion of community partnerships extended to entities such as the NSF, which promotes collaborative partnerships to increase the level of community science education. The NSF provides funding to educational and research projects in an effort to promote scientific discovery and education (NSF, 2007). Understanding the important role local universities play in their communities, ASU has been successful in securing NSF funding for various community and K-12 education projects. The funding is used to create community outreach and education programs such as the ASU Science is Fun program. Founded in 1997, Science is Fun is free to public schools and involves university researchers in developing science demonstrations that incorporate state and national science standards with current scientific research. The program promotes STEM literacy, education, and careers.

Several students who participated in the Science is Fun program as children have become mentors for students currently in the program. These program "alumni" have credited Science is Fun for sparking their interest in science. They are proof that community outreach is an important factor in the improvement of education

in Arizona. As required by NSF, the Science is Fun program promotes scientific literacy and encourages students to do well in STEM subjects, take STEM majors in college, and work in STEM fields (NSF, 2011). Endeavors such as this have aided in the creation of a STEM education pipeline from grade school to college, and from college to the professional world.

## STEM Survey

Although some studies show that subjects such as reading are improved through the help of parental participation, and subjects such as mathematics and science are shown to require a good teacher for better student performance, it is agreed that parental support and involvement encourages children to do well in all subjects (Lubienski & Lubienski, 2006). This part of our study focused on the level of parental support and respondents' participation in local community organizations, as reported by current African American Arizona STEM professionals.

Current Arizona African American STEM professionals were asked to participate in an anonymous survey to determine if parental support and/or involvement in community organizations played a role in their decision to undertake STEM majors in college.

### STEM professionals were asked the following questions:

1. What was your major in college?
2. What is your current profession?
3. How did you become interested in science, technology, engineering, or mathematics?
4. Choose the item that best describes your situation from kindergarten through high school:
  - I had very strong support and involvement in my education from my parent(s)/ legal guardian
  - I had some support and involvement in my education from my parent(s)/ legal guardian
  - I had little support and involvement in my education from my parent(s)/ legal guardian
5. Choose the item that best describes your situation from kindergarten through high school:
  - I often participated in local clubs or organizations (example: Scouts, Boys & Girls Clubs, church club, etc)
  - I sometimes participated in local clubs or organizations (example: Scouts, Boys & Girls Clubs, church club, etc)
  - I never participated in local clubs or organizations (example: Scouts, Boys & Girls Clubs, church club, etc)
6. Choose the item that best describes your situation from kindergarten through high school:
  - My family often discussed my attending college
  - My family sometimes discussed my attending college
  - My family rarely discussed my attending college

Twenty-eight Black STEM professionals responded to the survey. The survey results fell into two categories, with twenty-five of the surveys falling into the "Child through adolescent" category, and three surveys making up the "Adult" category. The categories indicate the age at which each professional became interested in STEM-based subjects.

Results of the survey showed that of the twenty-five STEM professionals who became interested in STEM subjects as children or adolescents, twenty said they had strong parental support for their education, while 4 said they had some parental support. Only one participant reported little parental support in their education; however, this same participant acknowledged that the family discussed college and also participated in community-organization programs. In fact, the majority of participants had both parental and community support during their primary education.

The three survey participants who stated they did not develop an interest in STEM subject or careers until adulthood stated they had some or very little parental support in their education. Two of the three answered that they rarely discussed college in their family, whereas one stated that the family sometimes discussed college. Two of the three participants did, however, participate in community-organized programs.

The study is significant because it reinforces the idea that strong parental involvement in education provides the academic encouragement and support students need to achieve academic success. Although only two of the STEM professionals in the Child and Adolescent category indicated that their parents were their inspiration for becoming interested in STEM subjects or careers, all had either strong, or at minimum, some parental involvement throughout their academic careers. All but one participant came from families who regularly discussed their attending college. This supports the idea that parental involvement and community support for education can, in fact, help narrow some achievement gaps in student academic performance.

Of the participants in the STEM survey, an overwhelming majority had an involved parent, and they were also involved in some type of community project or program. Only two of the survey participants indicated having a parent who was a STEM professional or educator. This finding supports the notion that strong parental involvement may influence a child's academic success more strongly than any other factor.

## Conclusion

If the trend of decreased numbers of Black students choosing STEM majors and careers is to be reversed, schools must be responsible for creating a safe and stable learning environment for children and for providing an atmosphere that is conducive to learning. Schools are required to teach educational standards set by their districts, as well as state and federal government. They provide children with models of appropriate behavior and good citizenship, all while helping them to be expressive and creative, and to develop independence. Educational leaders are the first to admit that schools cannot do it alone. Public schools need public support. It takes the teamwork of educators, students, parents, and community organizations to help children achieve academic success and gain an education that will benefit them well beyond the school walls. For children to achieve true academic success, all parties must be committed to placing children's developmental needs and education first (Chase & Katz, 2002).

This essay provides a number of sources of information that demonstrate the positive effects of parental and community involvement in education. Our work supports the need for American public schools to encourage parental involvement and community support in children's education by design. Information on collaborative efforts shows that programs such as the ACBES Computer Camp and the ASU Science is Fun program are projects that assist children, schools, and families in helping to narrow the education gaps in Arizona. The literature reviewed for this essay sustain the notion that every school must welcome and encourage parental and community involvement in the educational development of children.

This essay also demonstrates that parental involvement has the power to improve a student's performance in school, regardless of socioeconomic background, race, ethnicity, religion, or parental educational background (Berger, 2000). For STEM education to succeed, our research observes that strong parental support can encourage students in all academic subjects, including STEM subjects. The findings throughout our study have supported the view that both parental

involvement and community support are essential to student academic success in all areas of study. Further research is needed to determine if any future increase in STEM college majors can be directly attributed to the community partnerships established today. Additionally, a larger study of school mission statements, goals, and parental/community involvement is needed to determine if there is a direct link between the level of community support and the established mission and goals of a school.

Parental involvement and community support can create better schools for all children. Collaborative partnerships can, and have, considerably improved the American public school system (Berger, 2000). Schools working together with parents and local organizations as an educational community have the opportunity to create a network that supports new ideas and helps resolve problems.

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Michael Vasquez



Clarence Boykin



Katherine Hickman





Traci Williams



Juan Gilbert



Rhoshawndra Carnes



Kenja Hassan

# Rising STEM Occupational Demands and Low African American Participation in Arizona's Scientific Workforce: Do Attitudes Toward STEM College Majors and Careers Matter?

**Jerlando F. L. Jackson, LaVar J. Charleston, Logan P. Middleton**  
**University of Wisconsin–Madison**

*Dr. Jerlando F. L. Jackson is an Associate Professor of Higher and Postsecondary Education in Educational Leadership and Policy Analysis at the University of Wisconsin–Madison. He is founding director of Wisconsin's Equity and Inclusion Laboratory (Wei Lab). Dr. Jackson's central research interest has been to explore workforce diversity and workplace discrimination in higher education.*

*Dr. LaVar J. Charleston is a Senior Research Associate and Lab Manager at Wisconsin's Equity and Inclusion Laboratory (Wei Lab) at the University of Wisconsin–Madison. Dr. Charleston's research focuses on the trajectory of underrepresented populations into highly technological positions and broadening participation for underrepresented groups in Science, Technology, Engineering, and Mathematics.*

*Logan Middleton is a Writing Fellow at the University of Wisconsin–Madison where he is pursuing his Bachelor of Arts degree in English and Communication Arts with an emphasis in Radio, TV, and Film. His research interests include the intersection of disability and Composition and Rhetoric in Writing Center contexts.*

**Chance W. Lewis**  
**University of North Carolina–Charlotte**

*Chance W. Lewis, Ph.D. is the Carolyn Grotnes Belk Distinguished Professor and Endowed Chair of Urban Education in the College of Education at the University of North Carolina at Charlotte. Additionally, he is the Founding Executive Director of the UNC Charlotte Urban Education Collaborative which is dedicated to disseminating the next generation of research on the improvement of teaching and learning in urban schools.*

**Juan E. Gilbert**  
**Clemson University**

*Dr. Juan E. Gilbert is an IDEaS Professor and Chair of the Human-Centered Computing Division in the School of Computing at Clemson University where he leads the HCC Lab. Recently, Dr. Gilbert received a 2011 Presidential Award for Excellence in Science, Mathematics, and Engineering Mentoring.*

According to the Bureau of Labor Statistics (2008), science, technology, engineering, and math (STEM) occupations constitute a growing sector of Arizona's economy. However, the number of African Americans earning degrees related to these occupations has not kept pace with this growth. Increasing the participation of African Americans in STEM education fields and occupations in Arizona is a vital part of growing and maintaining "the state's economic stature. This objective is made even more compelling by the projected average annual number of jobs in STEM fields in Arizona, estimated to reach 3,671 jobs each year from 2008–2018 (Bureau of Labor Statistics, 2008). This essay uses results from the State of Black Arizona STEM Attitudes Survey (SBASAS) to explore whether African Americans' attitudes influence or have an effect on STEM college majors and careers in the state's scientific workforce. Through logistic regression analysis, our results reveal the importance of career consideration, confidence in one's ability to be successful in STEM fields, and family support in the pursuit of STEM education and careers.

As the demographic landscape of the United States continues to change, the majority of children born in the 21st century will be in sociocultural groups that are currently underrepresented in science, technology, engineering, and mathematics (STEM) disciplines (Becker, 2000; Pearson, 2002). However, broader

participation from these groups in STEM professions, especially African Americans, is necessary to ensure the vitality of the U.S. scientific workforce (Charleston & Jackson, 2011; Moore, 2006; Pearson, 2002). While Caucasian males are the primary occupants of the United States' highest paying engineering and scientific positions (Charleston & Jackson, 2011), African American workers occupy less than 3% of these occupations (Moore, 2006). Although steps have been taken to alter the landscape of the scientific workforce—the National Sciences Foundation's Broadening Participation in Computing program provides an example; these patterns of workforce participation are projected to be relatively static in the 21st century (Moore, 2006).

From an educational standpoint, African American workers continue to be one of the least represented cultural groups in high-demand STEM fields. Prior research (e.g., McSherry, 2005; E. L. Anderson & Kim, 2006) indicated that the group comprises less than 10% of all students enrolled in STEM undergraduate programs at American higher education institutions, as well as less than 10% of all baccalaureate-program graduates. Additionally, research from the National Science Foundation (2006a, 2006b) reported that African American students account for only 8.3%, 6.6%, and 2.5% of science and engineering bachelor's, master's, and doctoral degree recipients, respectively. Caucasian, non-Hispanic, U.S. citizens account for 64.7%, 47.9%, and 42.4% of the bachelor's, master's, and doctoral degree recipients in science and engineering, respectively. This juxtaposition points to a significant representation gap in the scientific workforce.

African American workers face multiple obstacles should they choose to pursue STEM professions (Charleston & Jackson, 2011). Both historically and currently, they are more likely than their Caucasian counterparts to progress through the K–12 system without the necessary mathematics and science knowledge to achieve success at subsequent levels of education and in STEM-focused careers (Charleston & Jackson, 2011). Additionally, few African Americans have access to social capital, social resources, and interactions with STEM professionals. In comparison to many STEM career-oriented individuals, they may also lack the requisite family connections or networking systems to aide them in their pursuit of high-quality preparation for these occupational fields (Charleston & Jackson, 2011). Although participation in STEM fields has increased, African Americans consistently remain underrepresented in these jobs (Ashby, 2006).

Although the lack of African American participants in the scientific workforce constitutes a national problem, this essay locates such underrepresentation in the state of Arizona, urging policymakers to consider ways to encourage African American students to pursue STEM fields. Specifically, this essay asks: Do attitudes toward STEM fields among African American citizens in Arizona make a difference in the pursuit of college degrees and careers in these disciplines?

## **The Case in Arizona: The Pipeline to STEM Education and Careers for African American K–12 Students**

As Arizona seeks to expand the representation of African American people in its scientific workforce, it is imperative to understand current data that forecast the future of African American participation in STEM fields in the state. One relevant indicator is none other than this population's scores in critical mathematics and science classes, foundational courses that may lead to STEM professions. Data from the National Center for Education Statistics (2009a) document that the African American K–12 to STEM workforce pipeline as lacking; more than 70% of African American students in Grades 4–8 have yet to reach proficiency in these essential courses. Equally concerning, all students in Arizona public schools (a) scored lower than students in 44 states in fourth-grade mathematics achievement, (b) scored lower than students in 33 states in eighth-grade mathematics, (c) scored lower than students in 41 states in fourth-grade science, and (d) scored lower than students in 36 states in eighth-grade science (National Center for Education Statistics, 2009a, 2009b, 2009c, 2009d, 2009e; see Table 1).

**Table 1. African American Student Performance in Selected Content Areas and Grade Levels in Arizona**

Content Area	Grade level	Below basic	At basic	At proficient	At advanced
Mathematics	4	41	40	16	3
Mathematics	8	42	35	18	5
Science	4	48	39	13	--
Science	8	63	29	8	--

Source: U.S. Department of Education, National Assessment of Educational Progress, 2009

The Bureau of Labor Statistics (2008) indicated that Arizona will realize STEM occupational growth projected into 2018. Projections indicate that by 2018, the state will have the following number of STEM positions, either filled or available: (a) 67,675 computer and mathematical occupations; (b) 34,972 engineering occupations; and (c) 26,314 life science, physical science, and other science occupations—with a total projection of 3,671 job openings per year. As such, it remains critical that this talent comes from within the state’s borders, consists of a culturally and ethnically diverse workforce, and draws on the underrepresented African American population to strengthen the state’s scientific workforce.

The future of African American participation in STEM occupations continues to be an area of concern. Data in Table 2 illustrate how many Arizona-based African Americans earned STEM degrees out of the total number of STEM degrees awarded in 2008 and 2009: (a) associate level, 385 of 4,861; (b) bachelor’s degrees, 207 of 4,994; (c) master’s degrees, 13 of 1,159; and (d) doctoral degrees, 5 of 443. African American degree attainment in these STEM-based fields is extremely sparse and will have to increase substantially for this population to participate fully in Arizona’s scientific workforce. Accordingly, those who seek to shape the future of African American representation in the state’s scientific workforce ought to focus attention toward the academic achievement of this population during their elementary- and secondary-school years. Key policymakers must work to increase exposure to STEM fields and promote these disciplines as career options for students early in their academic trajectories.

**Table 2. Gap between the Number of Projected Annual Job Openings and of Degrees Awarded in STEM Fields in Arizona, 2008-2009**

	Degrees Awarded to African Americans	Degrees Awarded (2008-2009)
Doctor’s Degree	5	443
Master’s Degree	13	1,159
Bachelor’s Degree	207	4,994
Associate’s Degree	385	4,861
<b>Projected Annual Job Openings (2008-2018)</b>	<b>3,671</b>	

Source: Bureau of Labor Statistics. (2008). Employment Projections, 2008-2018. Washington, DC: Author

## STEM Occupational Aspirations and Choice

Research literature (e.g., L. W. Anderson & Krathwohl, 2001; Betsworth et al. 1994; Gottfredson, 2005; Tesser, 1993) informed that occupational aspirations and choice are a matchmaking process wherein vocational choices are made that not only satisfy individuals' interests and goals, but are also relative to the skills, abilities, and temperament that an individual possesses. In general, "this process requires that young people first learn the relevant attributes of different occupations and of their own developing selves, and then discern which occupations have rewards and requirements that match their still-evolving interests abilities, values, and goals" (Gottfredson, 2005, p. 72). Additionally, the cognitive demands of matching the skills, abilities, interests, and goals of an individual to a career choice are heavily seeded in the matching process. As it relates to this essay, the level and rate of cognitive growth of an individual may ultimately play a role in, not only when, but also if and how the decision is made among African American students to pursue STEM fields in the state of Arizona.

Personal interests, attitudes, and skills are often culturally situated and are more influenced by shared environments (Betsworth, 1994; Gottfredson, 2005; Tesser, 1993). Moreover, career interest and aspirations are typically the results of the close partnership between nature and nurture. These aspirations are more contingent on experience and culture than basic personality traits and abilities. The experiences that tend to cultivate specific career aspirations or occupational choice (e.g., STEM pursuits) are not accessible to all individuals of all ages and in all locations, because some careers and vocations like those in STEM fields require specialized concentration of cultural activity (Ackerman & Heggestad, 1997). Therefore, many young individuals do not participate in activities that would provide them with the experiences necessary to cultivate or validate their interests, abilities, and values in areas not common to their cultural context. This reality of career decision making helps illuminate the lack of participation of African American people in STEM fields as a result of the lack of sufficient mathematics and science preparation throughout the educational trajectory.

The behavior of individuals also plays a role in the opportunities to which they have access in that increased learning, which translates into options, occurs when individuals are active seekers, rather than passive consumers of information. Career-development literature (e.g., Ackerman & Heggestad, 1997; L. W. Anderson & Krathwohl, 2001; Betsworth et al., 1994; Gottfredson, 2005; Tesser, 1993) confirmed that individuals' behavior affects their opportunities in that actively seeking a means to make oneself competitive in a specific area (e.g., by seeking and acquiring special courses or training in STEM areas) serves to increase vocational opportunity. To be sure, the lack of initiative does not foster greater accessibility. On the contrary, individuals "further increase their opportunities when they actively mobilize support or assistance in pursuing their aims" (Gottfredson, 2005, p. 83). Accordingly, this essay aims to ascertain the attitudes of African Americans in Arizona that positively or negatively affect the levels of participation, aspiration, or initiation the participants report in cultivating their own STEM development and experiences.

## Illuminating Attitudinal Differences: State of Black Arizona STEM Attitudes Survey (SBASAS)

In an attempt to understand attitudinal difference among African Americans with regard to STEM majors and careers, logistic regression analysis was used with data from the State of Black Arizona STEM Attitudes Survey (SBASAS), a statewide investigation of the extent to which African American people's attitudes toward STEM majors and careers influenced their presence in Arizona's scientific workforce. A broad-based strategy was used to collect survey data between June and July 2011. Data were collected at 24 churches, two community events and meetings, and five community Listservs in Phoenix, Flagstaff, and Tucson. This effort resulted in 634 usable surveys. Among survey respondents, 61.7% were female and 38.3% were male, and the average age of individuals in the sample was 48. Approximately 27% of survey respondents had majored in a STEM field.

# Study Findings: Logistic Regression Results

Tables 3 and 4 show the results of two separate logistic regression models, designed to consider what matters in the decision-making process regarding whether to pursue STEM degrees and careers, respectively. Based on goodness-of-fit indices, both STEM major and career models were excellent fits. In the STEM major model, the results indicated that there were three variables that generated significant effects in the probability of the observed representation of individuals who pursued STEM majors (see Table 3). None of the background characteristics variables were significant. As for the attitude variables, the likelihood of pursuing a STEM major was increased if the individuals who considered selecting a STEM major felt that they had the ability to complete a STEM degree, or if they believed that their family supported their STEM degree pursuit.

*Table 3. Variable Codes and Descriptions*

Code	Descriptions
<b>Gender</b>	Gender of Participants [ Male referent group]
<b>Age</b>	Age of Participants [Continuous]
<b>Parent</b>	Parental status [No is referent group]
<b>Considered</b>	Considered selecting a major in STEM
<b>Society</b>	I think STEM is very important in our society
<b>Interesting</b>	I think STEM topics/subjects are interesting
<b>Difficult</b>	I think topics/subjects in STEM fields are difficult
<b>Ability</b>	I believe I would have the ability to get a degree in a STEM field I chose to major in STEM
<b>Assistance</b>	I think I could easily get assistance from faculty and peer students if I chose a STEM major in college
<b>Job Opportunities</b>	I think that majoring in STEM fields is associated with more job opportunities
<b>High Pay</b>	I believe jobs in STEM fields are associated with high pay
<b>Respected</b>	I think people working in STEM fields are respected in our society
<b>Self-Development</b>	I think I can get more opportunities for self-development/growth in STEM fields
<b>Community</b>	I think there are a lot of people majoring/working in STEM fields in my community
<b>Family Support</b>	I believe that my family highly supports or once supported me to get s degree in a STEM field
<b>Welcomed</b>	I believe that African Americans are welcomed in STEM-based careers
<b>Successful</b>	I believe that African Americans can have successful careers in STEM-based fields

In the STEM career model, the results indicated that there were five variables that generated significant effects on the likelihood that African American students would pursue STEM careers (see Table 4). As for background characteristics, female status and increases in age both increased the likelihood. Considering the attitude variables, the likelihood of pursuing careers in STEM increased if the individual considered selecting a STEM major, felt that they had the ability to complete a STEM degree, and if they believed that their family supported their STEM degree pursuit.

Table 4. Logistic Regression Output for the Decision to Pursue STEM Degrees

	B	S.E.	Wald	df	Sig.	Exp(B)
Gender (female)	.086	.224	.148	1	.700	1.090
Age	.011	.009	1.773	1	.183	1.011
Parent	.172	.266	.421	1	.517	1.188
Considered	.872	.119	53.881	1	.000	2.392
Society	-.009	.253	.001	1	.973	.991
Interesting	-.011	.241	.002	1	.963	.989
Difficult	.162	.116	1.947	1	.163	1.176
Ability	.412	.167	6.112	1	.013	1.510
Assistance	-.106	.145	.530	1	.467	.900
Job Opportunities	.061	.193	.100	1	.752	1.063
High Pay	-.192	.208	.855	1	.355	.825
Respected	-.160	.170	.891	1	.345	.852
Self-Development	.157	.162	.943	1	.332	1.170
Community	-.015	.115	.018	1	.893	.985
Family Support	.543	.155	12.339	1	.000	1.721
Welcomed	.017	.133	.016	1	.899	1.017
Successful	-.245	.175	1.962	1	.161	.783

The State of Black Arizona STEM Attitudes Survey demonstrated that African Americans were more likely to pursue a STEM degree if they had confidence in their ability to complete such a degree and if they believed their family would support their decision.

## Discussion: Data-Driven Conclusions about STEM Majors and Careers

The results from this study show that some STEM-related attitudes do matter for African Americans in Arizona regarding their pursuit of STEM majors and careers. **Nonetheless, five conclusions based on the analyses may be drawn from this study.**

- Being a female showed a positive relationship with pursuing a STEM career. There is current and emerging evidence that shows increasing enrollment of African American females, in particular, in STEM majors. For example, in 2007, women of all races earned half or more of all bachelor's degrees in biology, agriculture, and chemistry (National Science Board, 2010).
- Age showed a positive relationship with pursuing a STEM career. As it is likely that those who are more stable in their career choices are older, one could speculate that age is potentially acting as a proxy for experience.
- African American students who seriously considered selecting a major in STEM were more likely to pursue STEM majors and careers. Although this may seem intuitive, it is important to note that underrepresented groups do not always give equal consideration to all vocational options (Gottfredson, 2002).
- African American students who believed that they had the ability to obtain a degree in a STEM field were more likely to pursue STEM majors and careers. It stands to reason that confidence in one's ability to succeed in a degree program or career plays a crucial role in decision making.
- African American students whose families supported their efforts to pursue a STEM degree were more likely to pursue STEM majors and

careers. Family support is a critical aspect of college and degree selection for African American students (Maton & Hrabowski, 2004; Moore, 2006), as moving into “new” academic fields is difficult without an appropriate support system.

## Final Remarks: Implications for Shaping Occupational Aspirations

Career-development and occupational-choice literature emphasized the idea that career choice and aspirations are a match-making process whereby the choice satisfies the individual's interests and goals, and are also relative to the skills, abilities, and temperament the individual possesses (L. W. Anderson & Krathwohl, 2001; Betsworth et al., 1994; Gottfredson, 2005; Tesser, 1993). Accordingly, age, serious consideration of STEM major and career, beliefs regarding one's ability, and family support affirm these assertions in this study (see Table 5). Age can be linked to the participant's skills, abilities, and temperament, indicating that experience and maturation inform participants' interests and goals toward STEM. Likewise, an increase in age increases the likelihood that cognitive demands indeed match the skills, abilities, interests, and goals necessary to effectively pursue a STEM career among the participants.

Table 5. Logistic Regression Output for the Decision to Pursue STEM Careers

	B	S.E.	Wald	df	Sig.	Exp(B)
Gender (female)	.499	.227	4.826	1	.028	1.647
Age	.032	.009	12.393	1	.000	1.032
Parent	.019	.277	.004	1	.947	1.019
Considered	.785	.120	42.756	1	.000	2.193
Society	-.144	.251	.331	1	.565	.866
Interesting	.111	.249	.200	1	.655	1.118
Difficult	.202	.118	2.911	1	.088	1.224
Ability	.405	.171	5.586	1	.018	1.499
Assistance	-.039	.146	.071	1	.790	.962
Job Opportunities	-.028	.200	.019	1	.891	.973
High Pay	.212	.212	.999	1	.318	1.236
Respected	-.135	.172	.614	1	.433	.874
Self-Development	.141	.162	.762	1	.383	1.152
Community	-.130	.116	1.262	1	.261	.878
Family Support	.474	.157	9.070	1	.003	1.606
Welcomed	-.194	.132	2.164	1	.141	.824
Successful	-.037	.181	.042	1	.837	.963

Although the participants in the State of Black Arizona Stem Attitudes Survey indicated that they did not have significant exposure to STEM early in life, many developed a positive attitude towards STEM careers with age and increased learning. The study suggests that self-efficacy is among the most significant factors in whether or not African American Arizonans pursue STEM careers today.

It appears that many of the early experiences of the participants did not cultivate specific career aspirations or occupational choices toward STEM. The variables of society, interest, assistance, high pay, respect, community, and success were not prevalent enough in the social networks of participants throughout their educational trajectory to promote the necessary self-efficacy to pursue STEM (see Table 3). Opportunities in STEM were not made accessible for many

participants. However, increased learning, as proxy by increased age, indeed increased initiative among STEM participants, promoting positive behavior and attitudes toward STEM participants.

## Strategic Investments in Self-Efficacy

Prior studies (e.g., Leslie, McClure, & Oaxaca, 1998) that used self-efficacy theory as a construct implicitly presented evidence that attributed a student's self-efficacy and persistence in STEM to the input of teachers, parents, mentors, counselors, and/or peers. This essay provides evidence that supports this assertion by contending that participants' contemplation of selecting a STEM major, feeling that they have the ability to complete STEM coursework, and believing that their family supports pursuing such a degree all increase individuals' likelihood of pursuing a STEM degree or career.

That some variables—society, interest, assistance, high pay, respect, community, and success—produced negative effects corroborates the idea that self-efficacy may be the strongest predictor of educational or occupational participation in STEM, as none of these attributes require self-efficacy, nor do they lead to participation in STEM fields or careers, as recorded by this study. Although it may appear as if the “successful” variable could be included as an attribute of self-efficacy, this study codes it as the belief that African American people can have successful careers in STEM-based fields without explicit connection to individual beliefs. Ultimately, the variables of self-confidence, self-efficacy expectations, and others' support for belief in one's ability to successfully complete a specific task precipitated the default variables. Therefore, the study results corroborate that self-efficacy has the propensity to increase positive attitudes as they relate to STEM education and occupations, thus increasing the likelihood of participation in the scientific workforce among Arizonian African American people at large.

Self-efficacy, or confidence in one's own abilities, is heavily involved in not only individuals' educational and occupational choices (Bandura, 1977), but also serves as a predictor of their workforce-related desires and interests (Bandura, 1986). More plainly, self-efficacy in STEM is represented by African American students' confidence in their abilities to succeed in science and mathematics; which ultimately increases the likelihood that this population will aspire to work in STEM fields. As STEM-related literature stresses the importance of recognizing the connection between self-concept (confidence and ability) in STEM education and occupation (Leslie et al., 1998; Meece, Parsons, Kaczala, Goff, & Futterman, 1982), students are more likely to enroll in optional or additional mathematics and science courses if they believe they maintain a higher level of ability in these subjects. It is this confidence that assures students they will succeed in STEM occupations, and thereby facilitates STEM aspirations and occupational decision making toward STEM fields. In most cases, it is some combination of teachers, parents, mentors, counselors, and/or peers that influence a student's self-efficacy and persistence in STEM, though this evidence has been more implicit than explicit in the literature (Leslie et al., 1998). In any case, African American students are often poorly advised and frequently discouraged from pursuing advanced courses in STEM education fields; this contributes to a lack of self-efficacy, which dominos into disproportionate participation in the disciplines in the STEM workforce (Moore, 2006).

In concert with other studies on occupational choice (Hackett & Betz, 1981; Hackett & Campbell, 1987; Lent & Hackett, 1987), the results of this study established a linkage between pertinent attributes or influences to self-efficacy and STEM. This essay drew connections to attitudes toward educational and occupational aspirations and decision making in the context of African American STEM careers in Arizona, thus unlocking the components that enable confidence among study participants to better elucidate their decision-making processes and attitudes with regard to STEM. Given its role in career development, self-efficacy, among other aspiration and choice factors, provides a means to explain the alignment between attitudes, confidence, aspirations, and ultimately the selection of STEM as an educational and occupational path.

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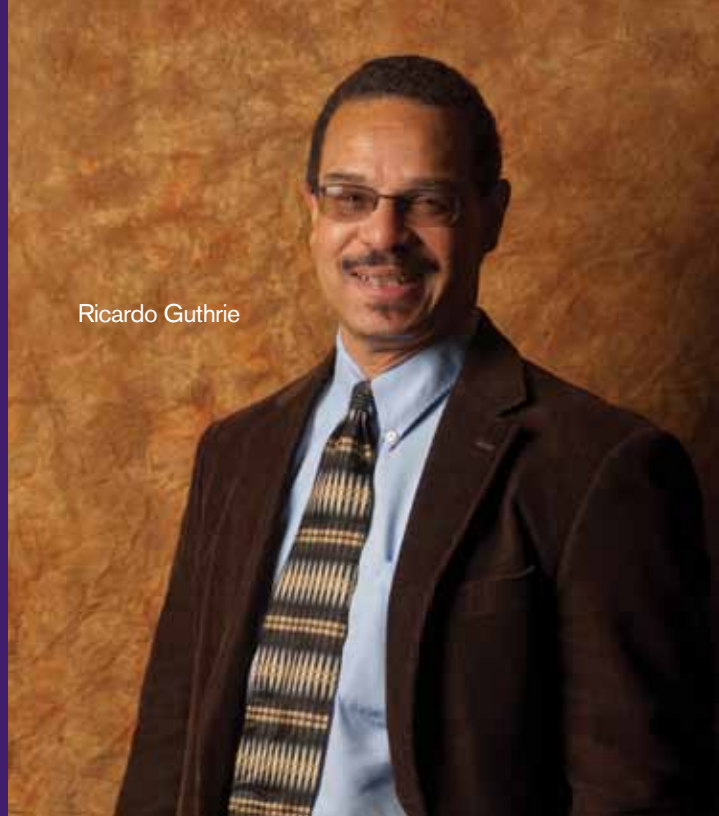
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Keva Womble



Patricia Crenshaw



Ricardo Guthrie

Monica Stigler



Kerwin Brown



Elsie Moore



# Increasing the Number of African American Students in STEM Careers: What Works and What Doesn't

**Celestine H. Pea**  
**Program Officer at the National Science Foundation**  
**Education Directorate, Division of Research on Learning**

*Celestine H. Pea, Ph. D., is a Program Director at the National Science Foundation, Education Directorate, Division of Research on Learning. Dr. Pea works with the Research and Evaluation on Education in Science and Engineering programs and has substantial experience working with state and federal agencies; universities, school districts, and education stakeholders from the broader community; and business and industry regarding science, technology, engineering, and mathematics (STEM) education.*

This chapter focuses on the achievement of African American (AA) students in science, technology, engineering, and mathematics (STEM) in Arizona. It discusses AA achievement through the National Assessment Education Progress (NAEP), a national report card that informs the public about the academic achievement of elementary and secondary students in the United States. Additionally, this chapter discusses the Arizona Instrument to Measure Standards (AIMS), which underscores where AA students place on the state assessment measure. The chapter examines research strategies and interventions shown to be effective in addressing context factors that might impede student achievement in STEM. Further, it highlights ways Arizona university partners are assisting students with their understanding of STEM by exposing them to higher level research and experiments. Finally, this chapter recommends research based practices and interventions state and local officials might consider to improve STEM education for AA students.

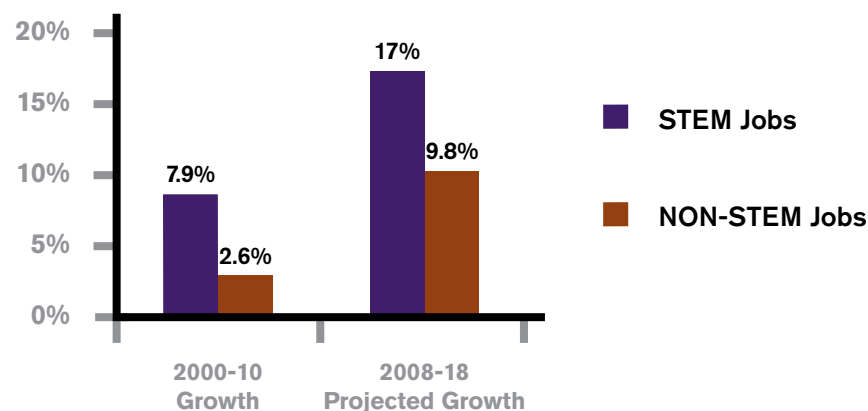
In *Creating the opportunity to learn: Moving from research to practice to close the achievement gap* (2011), Boykin and Noguera looked to current and recent research to build a strong case for promoting success for all children. These researchers argued for the use of best practices, models, and strategies about what works effectively to prepare a greater number of students for the 21st century STEM workforce. They are not alone. National and local stakeholders are working collaboratively to improve STEM education for all. The Opportunity Equation, a report released by the Carnegie Corporation (2009), stated that “excellent mathematics and science learning for all American students will be possible only if we do school differently in ways that place mathematics and science more squarely at the center of the educational enterprise” (p. vii). In *Taking Science to School*, the National Research Council (2007) “states that ...children come to school with the cognitive capacity to engage in serious ways with the enterprise of science....as educators, we are underestimating what young children are capable of as students of science—the bar is almost always set too low.”(p. vii)

Hence, from many fronts, the focus is on dramatically changing the way all students are prepared in STEM such that they can fully participate in a STEM workforce. All signs point to a need for STEM professionals who are capable of helping to ensure national security, economic competitiveness, and global stability, as defined in the President's Council of Advisors on Science and Technology 2010 report. To meet these challenges, our nation needs a stronger educational infrastructure to embrace a world that is changing. According to the Opportunity Equation, “the United States must mobilize for excellence in mathematics and science education so that all students—not just a select few, or those fortunate enough to attend certain schools—achieve much higher levels of math and science learning” (Carnegie Corporation, 2009, p. vii). Never before has the nation had so many stakeholders endorsing the need to target minorities, particularly African American people, so imperatively in meeting the need for future STEM workers. Although the problem, in general, is too few minorities in STEM fields, African American students must be prepared to embrace this golden opportunity to contribute to the future in much greater numbers.

Data indicate that STEM jobs are on the rise. The 2011 National Survey on STEM education by the U.S. Department of Commerce reported on recent and projected growth in STEM and non-STEM employment and found that STEM jobs are on the rise. The Science and Engineering Indicators (SEI, 2011) produced annually by the National Science Foundation (NSF) corroborate this finding. The survey also indicated that workers with jobs in STEM fields are more likely to

“earn 26 percent more on average than their non-STEM counterparts“ (p. 2). Data from the Current Population Survey and the Bureau of Labor Statistics show that STEM-related jobs grew exceptionally fast over the last decade and projected that STEM-related jobs will grow even faster over the next decade (see Figure 1). This impending need for more STEM graduates provides great opportunities for African American students and other minorities to join the STEM workforce.

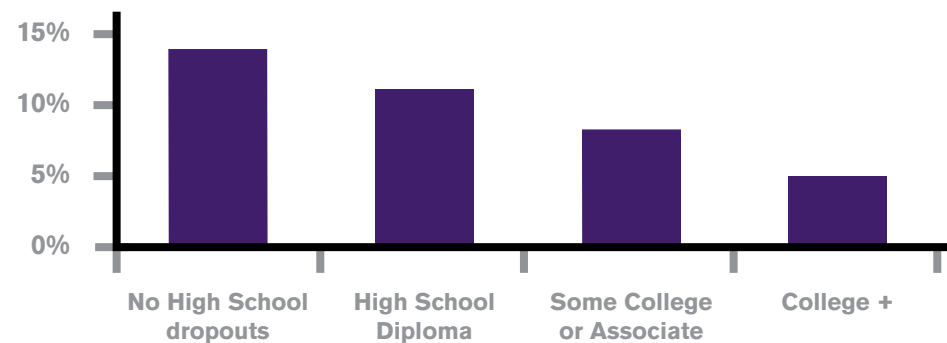
Figure 1. Projected growth in STEM-related jobs.



Source: U.S. Department of Commerce, Economics and Statistics Administration. Employment Projection Program of the Bureau of Labor Statistics. (2011). STEM: Good Jobs Now and for the Future. Retrieved from [http://www.esa.doc.gov/sites/default/files/reports/documents/stemfinaljuly14\\_1.pdf](http://www.esa.doc.gov/sites/default/files/reports/documents/stemfinaljuly14_1.pdf)

Carnevale, Smith, and Strohl (2010) reported that by 2018, the nation will need to increase college degrees conferred by about 10% annually to meet workforce demands. It has been reported by other national stakeholders that the 41% conferred in STEM annually, will need to increase to 60% to meet the country’s needs over the next decade. This does not bode well for Arizona where a significant number of students drop out of school and will likely face higher unemployment (see Figure 2).

Figure 2. Arizona 2009 unemployment status by education.



Source: Alliance for Excellent Education, (2010a). The Economic Benefits of Reducing the Dropout Rate Among Students of Color in the Nation’s Largest Metropolitan Areas. Retrieved from [http://www.all4ed.org/publication\\_material/EconMSA soc](http://www.all4ed.org/publication_material/EconMSA soc).

The National Academy of Sciences (NAS, 2010) urgently called for the need to increase the involvement of “underrepresented minorities and the quality of their education” in STEM fields.

Underrepresented minorities—including African Americans, Hispanics, and Native Americans—comprised just fewer than nine percent of minority college-educated Americans in science and engineering occupations in 2006, the report notes. This number would need to triple to match the share of minorities in the U.S. population. And to reach a national target that 10 percent of all 24-year olds hold an undergraduate degree in science and engineering disciplines, the number of underrepresented minorities would need to quadruple or even quintuple. (NAS, 2010, p. 1)

The call for greater minority participation in STEM is not going unheard.

Nationwide, approximately 94% of students say they plan to go to college, but 36% actually do. Of that amount, 55% attend a 4-year institution and earn a bachelor’s degree in 6 years. For all undergraduate students in Arizona, more than 39% earn a bachelor’s degree in 4 years; for African American students, 21% do (National Center for Education Statistics, 2010a). Fourteen percent of bachelor’s degrees conferred were in STEM fields. Nationally, the percent is 15 (see Table 1).

**Table 1. Arizona’s College Graduation Rates Versus National Average**

	Arizona 4-year Institution*	National Average*	2-year Institution**	National Average**
All students	39%	56%	44%	31%
White	44%	59%	46%	32%
Hispanic	44%	46%	40%	29%
African American	21%	39%	36%	26%
Asian	51%	66%	48%	33%
American Indian	34%	38%	38%	27%

Note. \* Graduation within 6 years of entrance (cohort 2002–2008); \*\* Graduation within 3 years of entrance (cohort 2005–2008)

Source. Alliance for Excellent Education (2010). *The Economic Benefits of Reducing the Dropout Rate Among Students of Color in the Nation’s Largest Metropolitan Areas*. Retrieved from [http://www.all4ed.org/publication\\_material/EconMSAsoc](http://www.all4ed.org/publication_material/EconMSAsoc)

The Business Higher Education Forum (BHEF, 2010) noted that minorities select STEM majors similar to their counterparts; however, they either do not complete STEM degrees or change to another major (NAS, 2010; SEI, 2010). In general, students list large lecture format with little or no discussion, low teacher expectations, STEM courses with few scaffolds to assist with difficult concepts, maintaining grade-point average (GPA) to help keep grant support, and few mentors as reasons why they do not complete STEM majors. African American students face additional factors, which include competitive and intimidating introductory courses, textbook-oriented teaching, disconnection from the real world, stereotype threats, and the mining-and-sorting approach that selects only the “best and the brightest.” Further, African American students noted low teacher expectation, lack of teacher qualification, and excessive disciplinary referrals due to their behavior in class (Boykin & Noguera, 2011; Gillen-O’Neel, Ruble, & Fuligni, 2011; Losen, 2011; Tenenbaum & Ruck, 2007) as factors for noncompletion of a STEM degree. Still others included a feeling of not belonging, race/ethnicity, stereotype and identify threats, lack of values affirmation, limited prior experience, low self-efficacy, little or no parental or mentor support, and lack of adequate financial support (Arbutnot, 2009; Boykin & Noguera; 2011; Cohn & Garcia, 2008; Cohn et al., 2006). Collectively, these factors contribute to lower achievement by African American students in STEM courses leading to fewer selecting STEM careers.

National and state data must be used to shore up African American students where they are falling short. There is also a need to be persistent in using lessons learned to combat factors that interfere with student performance: aggressive in implementing proven strategies and interventions to help more students excel in STEM, mindful of existing opportunities that are helping to seal leaks in the STEM pipeline, and dutiful in increasing awareness of the vast possibilities a career in STEM brings to the future workplace. It is time to be deliberate in using what we know works in ways to ensure equity, equality, and excellence for all students, in particular, those of African American backgrounds.

## Insights Into Current Conditions for African American Students K–12 in Arizona

**K–12 public school student population.** The Arizona Instrument to Measure Standards (AIMS) and National Assessment Education Progress (NAEP) data show that the state's K–12 public school student population is slightly more than 1.1 million. Of that number, the African American K–12 public school student population hovers between 5 and 6%. African American people make up the smallest subgroup of minorities in Arizona, at approximately 4.1% of the overall population. It seems highly likely that African American students could be positively impacted by the state's efforts to improve education for all students in STEM education.

**Mathematics and science achievement.** To successfully increase the number and diversity of students choosing and performing successfully in STEM careers, an all-encompassing, rigorous course of study is needed. To that end, Arizona is one of 48 states, in addition to Washington, DC and two territories, that developed the Common Core Standards in mathematics (2010). It is one of 44 states that adopted the standards in mathematics as well as one of 45 states working to create common assessment systems scheduled for availability in 2014–2015. To set higher curriculum standards in science, the NRC, and Achieve (2011), along with many stakeholders groups, are developing K–12 standards in science. This effort ensures that K–12 science gets standards comparable to those for mathematics. Achieve was created by the nation's governors and corporate leaders in 1996, Achieve helps states raise academic standards and graduation requirements, improve assessments and strengthen accountability. It is based in Washington, D.C., and operates as an independent, bipartisan, non-profit education reform organization.

Achievement in mathematics and science is critical to building a strong foundation for STEM careers. Many educators assert that students who choose STEM careers are those who score proficient or above on standardized tests. This assertion can be particularly problematic for African American students, because a low percentage of these students reach these benchmarks on the AIMS and NAEP tests.

**AIMS results.** Student mathematics and science performance in Arizona is assessed on the AIMS tests at Grades 4, 8, and 10. Test data show that for 2009, over 97% of all public school students took the mathematics test, while over 83% took the science test.

AIMS demographic data at the tested grades were not available. However, tables taken from the Research and Evaluation Section of the State Department of Education show that overall student performance on the mathematics tests increased slightly in 2011. Approximately 59% of students passed the AIMS assessment in mathematics, which was 2% higher than in 2010 at 57%. For science, student percent passing rate was significantly lower than mathematics at 35% passing, which was a 2% increase over the year before.

**NAEP assessment: mathematics.** In addition to the AIMS assessments, Arizona was one of the states that participated in the 2009 NAEP tests. Sometimes called the Nation's Report card, NAEP sets a consistent bar for student performance across states and tracks international assessments. On NAEP, the scale score ranges from 0 to 500. The following figures display student achievement at Grades 4 and 8. As indicated in Table 2, African American students' average scores at Grade 4 were slightly higher than those of other minority groups in most categories, yet were significantly lower than the scores of White and Asian/Pacific Islander students in nearly all categories.

**Table 2. Arizona NAEP 2009 Mathematics: Results of Student Groups Grade 4**

Reporting groups	Percent of students	Percent at or average score	Percent at or above basics	Percent at or above proficient	Percent at advanced
<b>Gender</b>					
Male	51	230	70	30	4
Female	49	230	71	26	3
<b>Race/Ethnicity</b>					
Caucasian	40	243	86	44	7
African American	6	222	59	19	3
Hispanic	45	220	60	15	1
Asian/Pacific Islander	3	245	87	45	2
American Indian/ Alaska Native	6	215	51	13	1

Source. 2009 Mathematics Assessment. (2010a). U. S. Department of Education. Institute of Education Sciences. National Center for Education Statistics National Assessment of Educational Progress. Retrieved from <http://nces.ed.gov/nationsreportcard/science/whatmeasure.asp>

As shown in Table 3, African American students' score scores were slightly higher than those of other minorities, yet, significantly lower nonminority students.

**Table 3. Arizona NAEP 2009 Mathematics: Results of Student Groups Grade 8**

Reporting groups	Percent of students	Percent at or average score	Percent at or above basics	Percent at or above proficient	Percent at advanced
<b>Gender</b>					
Male	50	279	68	31	7
Female	50	276	67	26	5
<b>Race/Ethnicity</b>					
Caucasian	44	293	81	42	11
African American	5	269	58	23	5
Hispanic	42	265	56	16	1
Asian/Pacific Islander	3	295	81	52	18
American Indian/ Alaska Native	6	254	43	12	2

Source. 2009 Mathematics Assessment. (2010b). U. S. Department of Education. Institute of Education Sciences. National Center for Education Statistics National Assessment of Educational Progress. Retrieved from <http://nces.ed.gov/nationsreportcard/science/whatmeasure.asp>

**NAEP assessment: science.** The NAEP science assessment was updated in 2009 to keep the content current with key development in science, curriculum standards, assessments, and research (NCES, 2009). (p. 1). In science, at Grade 4 in Arizona, the average score was 129 (see Table 4), which was lower than the average for White and Asian students. This was also lower than the average score of 149 for public school students in the nation. Again, data illustrated in Table 4

show a double-digit achievement gap between African American students and their White and Asian counterparts.

For Arizona, the average score in science at Grade 8 was 141. This was lower than the average score for the nation, which was 149. African American students' average score on the NAEP science test was 126, which was significantly lower than the average score for White and Asian students (see Table 5).

**Table 4. Arizona NAEP 2009 Science: Results for Student Groups Grade 4**

Reporting groups	Percent of students	Percent at or average score	Percent at or above basics	Percent at or above proficient	Percent at advanced
<b>Gender</b>					
Male	51	137	60	23	0
Female	49	138	61	21	0
<b>Race/Ethnicity</b>					
Caucasian	40	155	81	37	1
African American	6	129	52	13	0
Hispanic	45	124	45	9	0
Asian/Pacific Islander	3	156	78	43	0
American Indian/ Alaska Native	6	123	43	9	0

Source. 2009 Science Assessment. (2010c). U. S. Department of Education. Institute of Education Sciences. National Center for Education Statistics. National Assessment of Educational Progress, Retrieved from <http://nces.ed.gov/nationsreportcard/science/whatmeasure.asp>.

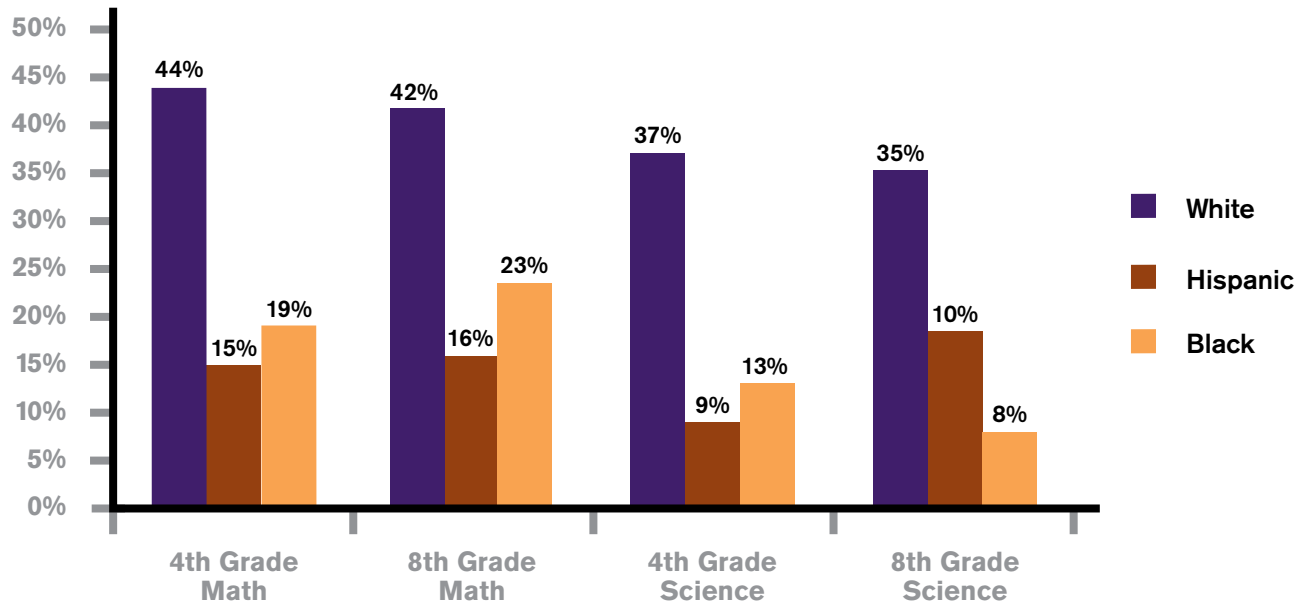
**Table 5. Arizona NAEP 2009 Science: Results for Student Groups Grade 8**

Reporting groups	Percent of students	Percent at or average score	Percent at or above basics	Percent at or above proficient	Percent at advanced
<b>Gender</b>					
Male	51	143	56	26	1
Female	49	139	51	18	0
<b>Race/Ethnicity</b>					
Caucasian	45	157	74	35	1
African American	5	126	37	8	0
Hispanic	42	127	36	10	0
Asian/Pacific Islander	3	159	68	43	5
American Indian/ Alaska Native	5	126	35	7	0

Source. 2009 Science Assessment (2010d). U. S. Department of Education. Institute of Education Sciences. National Center for Education Statistics National Assessment of Educational Progress Retrieved from <http://nces.ed.gov/nationsreportcard/science/whatmeasure.asp>

Overall, in Arizona, mathematics and science students scored below the national average at Grades 4 and 8. Additionally, at both grade levels, African American students scored significantly lower than their White and Asian counterparts. Therefore, a double-digit gap remains (see Figure 3).

Figure 3. **Significant achievement gap persists at all levels.**



Source: U. S. Department of Education. Institute of Education Sciences. National Center for Education Statistics National Assessment of Educational Progress, (2010e). Retrieved from <http://nces.ed.gov/nationsreportcard/science/whatmeasure.asp>

## Graduation Rates

Critical to increasing the number of students choosing STEM careers is ensuring a greater number of students remain in school and graduate from high school and, later, college within 4 years. However, information from the Current Population Survey, the Alliance for Excellent Education (2011), NCES, and state data indicated that, in Arizona, approximately 68% of the ninth-grade students graduate from high schools in 4 years. For African Americans, 72.6% of students graduate from high school in 4 years; for the nation, the average is 69% (see Table 6).

**Table 6. Percentage of Students Graduating from High School Class of 2010**

	Number graduated	Number in cohort	Arizona	Nation
<b>All students</b>	57,520	75,575	76.1%	69%
<b>White</b>	30,535	36,682	83.2%	76%
<b>Hispanic</b>	18,978	27,421	68.6%	55%
<b>African American</b>	3,184	4,386	72.6%	51%
<b>Asian</b>	1,909	2,167	88.1%	79%
<b>American Indian</b>	3,094	4,919	62.9%	50%

Source. Accelerating the College and Career Readiness of Arizona's Student (2011). Alliance for Excellence in Education. Retrieved from [http://www.all4ed.org/files/Arizona\\_cs.pdf](http://www.all4ed.org/files/Arizona_cs.pdf).

Arizona is one of a few states that have graduation rates for African American males that are close to, or higher than, the average state graduation rate for White, non-Hispanic male students. For fiscal year 2010, the graduation rate for African American males for the nation as a whole was 45%.

Studies also show many schools are exceptions to large achievement gaps and low graduation rates. For example, John S. Davidson Fine Arts Magnet School in Augusta, Georgia is a prime example. The school offers a basic curriculum of college preparatory and advanced-placement academic courses, along with fine-arts courses (e.g., visual arts, music, chorus, dance, cinema production, and theatre). This National Grammy Signature School also placed in the top 100 tier of Newsweek's "America's Best High Schools." From 2008 to 2010, an overwhelming majority of students passed the high school graduation tests in mathematics and science, had 100% graduation rates from 2007 to 2010, and met 100% of adequate yearly progress (AYP) measures in 2010. A state of the art solid curriculum, high expectations, and a nurturing staff helped students excel in all areas.

## Dropout Rate

Despite numerous efforts, many students drop out of school each year. According to the Current Population Survey, depending on the subgroup, the overall dropout rate is lowest for Asian students and highest for English-language learners. The Current Population Survey uses the National Educational Longitudinal study databases, which track individual students over time and verify diplomas against actual transcripts, show overall national graduation rates of 82% and rates for black and Hispanic students of about 75%. The Arizona Department of Education (2010) reported that the African American students' dropout rate is 3% (see Table 7).

**Table 7. Arizona: 2009–2010 Dropout Rates by Subgroup**

Subgroup	Number of students enrolled	Number of dropouts	Dropout rate
All students	506,535	13,891	2.7
Asian	15,441	136	0.9
African American	31,816	962	3
Economically disadvantaged	228,668	7,138	3.1
English-language learners	22,096	745	3.4
Female	246,011	5,720	2.3
Hispanic	203,780	6,902	3.4
Male	260,524	8,171	3.1
Migrant	1,821	23	1.3
Native American	29,974	2,041	6.8
Special education	56,889	1,813	3.2
White	225,524	3,850	1.7

Source. Recent Reports Greatly Understate High School Graduation Rates, by Economic Policy Institute, n.d., retrieved from [http://epi.3cdn.net/769f53e44b235b9ef8\\_pqm6bhnlw.pdf](http://epi.3cdn.net/769f53e44b235b9ef8_pqm6bhnlw.pdf)

Students list boredom, less than challenging curriculum, unmotivated adults they spend time with at school, lack of motivation, low expectations by teachers and administrators, and lack of parental support as reasons they drop out of school (Bridgeland, Dilulio, & Morrison, 2006; Rumberger, 2011). Documented results show that many schools cannot verify how many students are present in school. Nor can schools accurately report the number of students who graduate each year and the number who have dropped out. Regardless of who paints the picture, most researchers and agencies that monitor education agree that the national dropout rate looms near 35%. For Whites and Asians, the percentages are about 27% and 25%, respectively, whereas for African American students and other minorities, it is slightly more than 50%.

Despite these percentages, those who drop out of school believe that they have the academic ability to graduate, and 81% recognize that graduating is essential to their success. Studies about dropout support students' claims. Reports show that many students who drop out are not failing, and if students are failing, they have the wherewithal to complete high school or college. Moreover, students know dropping out usually leads to poverty, a shorter lifespan compared to people who graduate, and earning power that is less than \$20,000 per year (Bridgeland, Dilulio, & Morrison, 2006; Bureau of Labor Statistics, 2011; Rumberger, 2011). Losen (2011) as well as Boykin and Noguera (2011) called for more research on whether African American people and other subgroups who face excessive suspension miss important instructional time and are at greater risk of disengagement, diminished educational opportunities, and higher dropout rates (Losen, 2011, p. ii) Losen noted that there are no policies that require school personnel to "report or evaluate the impact of disciplinary decisions" (2011, p. i).

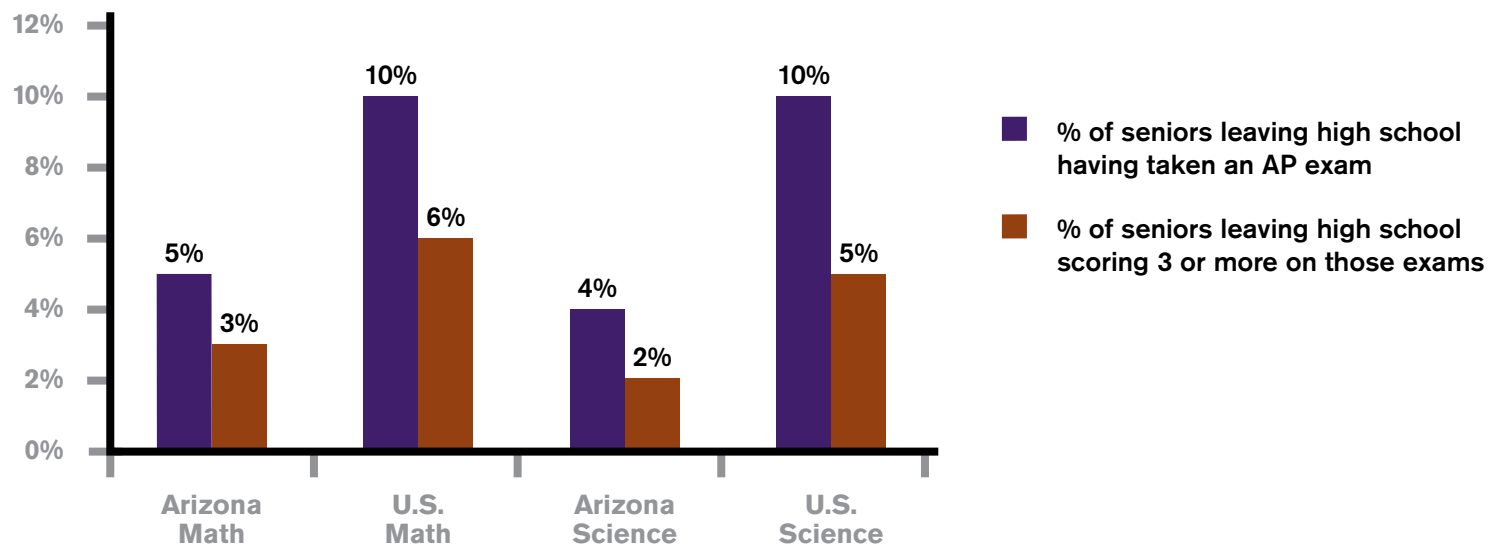
## Readiness for College

With a projected shortfall in college graduates by 2018 and the economic downturn, college is becoming as much of a necessity for the nation as it is a dream for an individual. In addition to providing a better K–12 STEM education, there is a push to get students to take more advanced coursework in high school, because science and mathematics are critical to college readiness.

The seventh Annual AP Report to the Nation (February 9, 2011) released by the College Board declared that “AP fosters college persistence and success” (College Board, 2011).’ (p. ii). “Moreover, the report showed that students who scored three or higher on four popular AP examinations earned higher first-year GPAs and were more likely to continue on to a second year of college” (College Board, 2011).” (p. 2). Even students who scored 1 or 2 on an AP examination showed higher retention rates into their 2nd year of college.

Research also shows that participation in “high-quality curricula measured by an external assessment such as AP Exam, significantly boosts the likelihood of traditionally underserved students’ future success in college.” (College Board, 2011).” ( p. 3) The study also showed that African American students “who took AP mathematics and science exams were more likely to major in related disciplines than peers who did not take AP” (College Board, 2011 )” (p. ii). Nationally, in 2010, 8.6% of the African American student AP population of 14.6% took the AP examinations. This number fluctuates over time. Further, when which examinations African American students are taking are reviewed, data show that mathematics and science are not in the five top most popular tests taken by African American students (see Figure 4).

**Figure 4. Percentage of advanced-placement takers with scores of 3 or more.**



Source: AP Fosters College Persistence and Success, by College Board, 2011, retrieved from <http://apreport.collegeboard.org/ap-college-persistence-and-success>.

## Collaboration Among Stakeholders

To meet projected needs for college graduates, schools and districts cannot succeed alone. Colleges and universities are needed to help students maximize their fullest potential in STEM education and careers. To demonstrate commitment to improving STEM education for all—and to highlight work in progress—a snapshot of grants to colleges and universities in Arizona by the National Science Foundation (NSF) will be used to demonstrate how institutions are supporting minority participation in STEM.

NSF is an independent federal agency created by Congress. It is the funding source for approximately 20% of all federally supported basic research conducted by America's colleges and universities. Through its annual budget, NSF supports over 200,000 scientists, engineers, teachers, and students through grants to colleges and universities, local education agencies, and private entities that support STEM education.

Arizona colleges and universities are recipients of over 1,000 federal grants ([www.nsf.gov/home/awards](http://www.nsf.gov/home/awards)). More than 75% of the awards in Arizona focus on minorities, whereas nearly as many target women. The scientists, engineers, and educators who oversee these grants are working with college and K–12 students (including minorities and those highly talented in STEM) to investigate new approaches in STEM, address cultural diversity, broaden horizons in STEM careers, help close the minority achievement and gender participation gaps in STEM, as well as obtain higher level STEM degrees and careers.

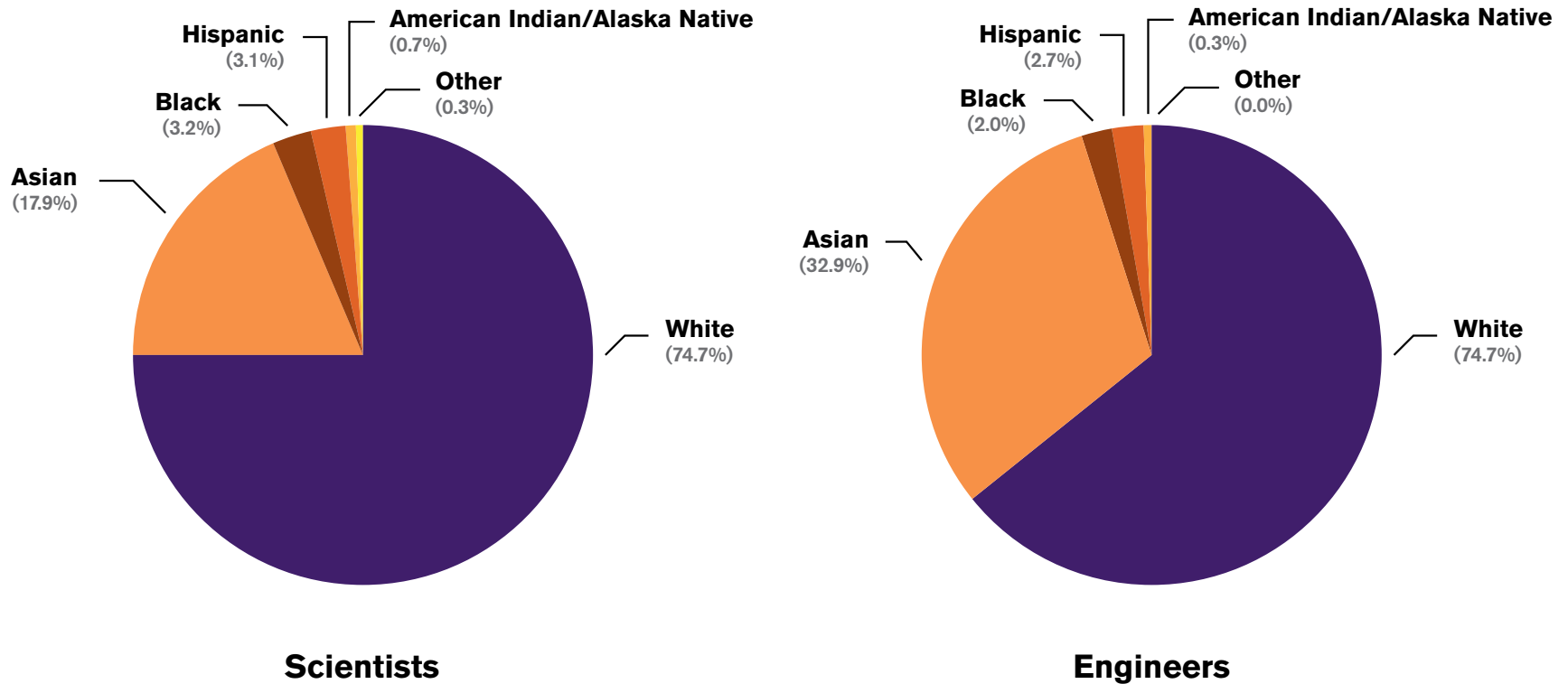
Students who benefit from NSF grants were provided scholarships, financial support, and scaffolds to ensure successful transitions to upper-division work, research, graduate school, and the STEM workforce. Additionally, students were mentored and participated in international travel to discuss important STEM global issues, as well as learn about different cultures. Students also participated in research that ranged from problem-solving in engineering to hands-on, technology-driven experiences in STEM-related fields that promote innovation and competitiveness.

Some colleges and universities are targeting African American students through partnerships with historically Black colleges and universities and other higher education institutions and education-focused entities. These partnerships provided some assurance that African American students were among those benefiting from these cutting-edge programs. For example, there was one collaboration among the NSF, Louis S. Tokes Alliances for Minority Participation, Western Alliance to Expand Student Opportunities, and NASA Space Grant mentor-guided undergraduate research project that used Intel, Microchip, and NASA technical mentors to help maintain more than an 87% retention rate and a graduate school full-time rate that nearly doubled the national rate. Another project employed 80 graduate and undergraduate students per year from participating universities (including Howard University), whereas another collaborated with Tuskegee University and Morgan State University to allow students to be part of advancing the emerging field of optical communications. Still another targeted several Phoenix high-needs districts and schools to include more students and their parents in technology-driven experiences in STEM-related fields that also promoted innovation and competitiveness. Finally, the snapshot revealed one opportunity where an African American female is working toward a Ph.D. degree in preparation for the professional workforce (see Figure 5).

## **National Breakdown of Doctorate Recipients from U. S. Universities.**

While the state of Arizona is contributing to the number of STEM graduates, nationally, the overall percentage for African American students remains bleak. Research shows a growing decline in students' interest in STEM field, and it is those students who score at the proficient or advanced levels that equate with STEM graduates. Few African Americans in the national STEM population (see Figure 5), end up scoring at the proficient or advanced levels. With so few in the pipeline, the picture is even bleaker for African American students .

Figure 5. Doctorate recipients from U.S. universities, 2009.



Source: Science and Engineering Indicators, 2011. National Science Foundation. . <http://www.nsf.gov/statistics/seind12/figures.htm>

The national call for 1,000,000 new STEM graduates over the next 10 years, in addition to the more than 300,000 produced annually, as well as 100,000 new STEM teachers provide great opportunities for all states to change the percentages in Figure 5 significantly (PCAST, 2010).

## Conclusions and Recommendations

According to NAEP and AIMS data, the information above tells a bleak but credible story. However, the trend is getting better for African American students nationally (NCES, 2011). In 16 of 35 states, in mathematics, student achievement improved slightly at Grade 4 and the gap narrowed between African American and White students at that grade level. The 2009 High School Transcripts Study, which sampled nearly 38,000 graduates representing approximately 3 million high school students, reported that graduates completed a more rigorous curriculum than their counterparts who participated in the 1990 transcript study. For African American students, the percent increase was 6%; whereas for Asian students it was 29%; for White students, 14%; and for Hispanic students, 8%.

Nationally in 2009, “African American graduates earned 3.9 more credits than in 1990. White graduates completed 3.7 credits more in 2009 than in 1990, Asian/Pacific Islander graduates completed 2.9 more credits, and Hispanics graduates earned 2.6 credits more.” (NCES, 2009). Across all four groups of students, higher GPA were also earned. However, students whose parents did not complete high school continued to take a lower level curriculum than those students whose parents did graduate (NCES, 2009). As a group, nationally on NAEP, African American students have performed better since 1990. They selected a more rigorous course of study, took more credits, and earned higher GPAs. However, as noted earlier, the best results were at Grade 4, where African American students narrowed the achievement gap with their White counterparts. Despite these increases, African American students’ scores remain significantly lower than those of their White and Asian/Pacific Islanders counterparts (NCES, 2009).

To change the direction of the gap, factors that hinder African American students’ selection of and persistence in STEM careers should be faced head-on nationwide. Many individual and scattered efforts—several funded by NSF—are proving to be fruitful in improving African American student performance overall. Yet, no one strategy, resource pool, or political influence has been successful in scaling-up proven practices capable of meeting the needs of minorities in STEM. Researchers argued that building a stronger foundation earlier in students’ educational careers is critically important to their success in later coursework like mathematics and science. Grissmer, Grimm, Alyer, Murrah, and Steele (2010) identified strong predictors of later achievement in mathematics to be fine motor skills and general knowledge of the world. Grissmer et al. further noted that parents should start as early as 9 months to expose their children to multiple experiences in both formal and informal settings. According to Thomas and Collier (2001) and Grissmer and Eisemann (2008), many African American students are far behind in skill development long before they enter school.

Research beckons a new call for parents to limit how long their children watch TV per day. A 2011 report released by the American Academy of Pediatrics recommended that watching television should be based on quality programming selected by parents. Additionally, children older than 2 should watch no more than 1 to 2 hours a day and those younger than 2 years old should not watch any TV at all. DeLoache et al. (2010) reported that infants learn relatively little from infant media. There are ongoing debates about whether children’s word learning from commercial media increase vocabulary and if infants learn as much as parents often think they do from symbolic media, including pictures, models, and video. Researchers agreed that children almost always learn significantly more from interactions with their parents (DeLoache et al., 2010).

For African American eighth-grade students, in 2003, nearly 61% watched 4 or more hours of television, compared with 24% of White students, based on the Child Trends,(2010). According to NAEP, African American students who watched 6 or more hours of television each day scored lower, on average, than did other students in mathematics. Similar scores were evident on the Third International Mathematics and Science Study in 1995: all countries with participating eighth-grade students who watched more than 5 hours of television per day had the lowest average mathematics scores. However, in 2008, the Child Trends Data Bank showed that at the eighth-grade level, the number of hours of conventional television watching for African American students dropped to slightly more than 53%, whereas for White students the decline was slightly more than 18%. But, when all television content is displayed on computers and handheld media devices (e.g., iPods, cell phones, videos, and portable DVDs) overall viewing actually increased by nearly 40 minutes per day from 1999 to 2009. Taken together, the number of hours per weekday increased significantly for African American students to about 7.5 hours of time.

Hulleman and Harackiewicz (2009) tested whether relevance of science to students’ lives promoted interest and performance. Their study showed that encouraging students to make connections between science-course materials and their lives promoted both interest and performance for students with low-success expectations. The effect was most striking for students who improved nearly two-third of a letter grade in the relevance condition, which is comparable to other social-psychological interventions aimed at reducing the Black–White achievement gap.

Even though fourth-grade African American students narrowed the achievement gap with their White counterparts at Grade 4, the overall double-digit (e.g., as high as 26 points in some instances at Grade 8 in mathematics) gap remains. Boykin and Noguera (2011) saw the gap as multidimensional, based on school indexes such as “grade point averages on national, state, local achievement tests, enrollment and completion of rigorous course, and differential placement in school” (p. 3). According to Boykin and Noguera, differential placement includes how students are assigned to special-education and gifted-and-talented programs. It also refers to a host of “behavior indicators such as school dropout, suspension, and referral rates” (2011, p. ii). Therefore, if African American students are to take advantage of opportunities for careers in STEM, the fastest growing workforce in the world, substantial changes must occur in an ongoing, nonthreatening manner.

## Proven Strategies and Interventions

Just as there are scores of educators who continue to research ways to buffer African American students from factors that impede student performance, increasingly, there are researchers investigating ways to determine how such data can be used to scale up effective practices. Notable strategies that have been tried and tested include values-affirmation, modeling, mentoring, video dyads, Olympiads, and out-of-school engagement. A couple of salient examples are described below.

## Consider Using Values-Affirmation Practices

Cohen and Garcia (2008) conducted randomized field interventions on values-affirmation to offset psychological threats in the classrooms. The researchers allowed students to reflect on a personal value that was important to them (e.g., friend, family member, or musical interest) in a series of structured writing assignments. The intervention reduced psychological threats and stress after one or two administrations with African American students, and had no adverse affect on White students.

Results showed that the intervention helped early poor performer’s GPA, lifted the angle of the performance trajectory, and lessened the degree of downward trend in performance characteristics of a recursive cycle. The greatest benefits from the intervention were among low-achieving African American students who are usually worse off or for whom performance is most magnified by stereotyping. Thus, the affirmation kept the achievement gap in check over time. After the initial treatment, no boosters were needed to sustain the intervention’s impact during the second year. Research by Miyake et al. (2010) showed that values-affirmation interventions also reduced performance differences between men and women where female students’ modal grade increased from a “C” to a “B.” The impact was strongest for females who endorsed the idea that males are better than females in STEM.

## Use Effective Models to Inform Local Change

Scientists and educators are engaged in cutting-edge research, and continue to endorse major changes in the ways the nation educates its youth. These stakeholders are calling for improved and different models for change; models like Ralph Bunche Elementary, a high-achieving school in California. This school thrives on a high-quality curriculum and weekly assessments to determine who is slipping, who is moving, and what else needs to be done. The principal serves as the instructional leader and model school-teacher leaders help other teachers get better at teaching and learning. With a student population that is over 51% African American, the results are stunning. In 2011, the school exceeded its academic performance index by 79 points (789/710). It also met all AYP goals, and more than 72% of the African American students scored at proficient or above level on the state’s assessment tests, whereas more than 68.9% of the school’s student population scored proficient or above. The greatest challenges facing the school include making sure that all students have strong foundational skills and come to school ready to learn, maintaining high adult (teacher) expectations that all students can learn, and sustaining a viable home–school communication program.

## Hire Adults Committed to the Success of Student They Serve

Schools should employ highly qualified adults committed to student success. In a 1999 landmark study by The Charles A. Dana Center (1999), The University of Texas, Austin, released a study report entitled *Hope for Urban Education: A Study of Nine High Poverty, High Performing Urban Elementary Schools*. The report showed that participating schools outperformed most schools in the state and nation in mathematics and reading. Although all nine schools used Title I funds to support schoolwide efforts, the “true catalyst was the strong desire of educators to ensure the academic success of the students they served” (Charles A. Dana Center, 1999, p. i).

In conclusion, small interventions can lead to large impacts when the treatment is repeated over time. The long-term effects of the NSF-funded grant in Arizona are yet to be assessed, but are worthy of investigation. How many of them include the effective strategies articulated above? Because research suggests that small interventions can reduce stereotypes and identify threats, improve student performance, slow widening of the achievement gap, and affirm a sense of self-worth, how many of these awards are replicable? Sustainable? In short, this chapter provides hope and suggests paths for reversing a troubling trend for African American students in Arizona and the nation. At no other time in the history of education (STEM), have there been so many supporters in agreement about the need to include all students in the quest to ensure national security, economic competitiveness, and global stability.

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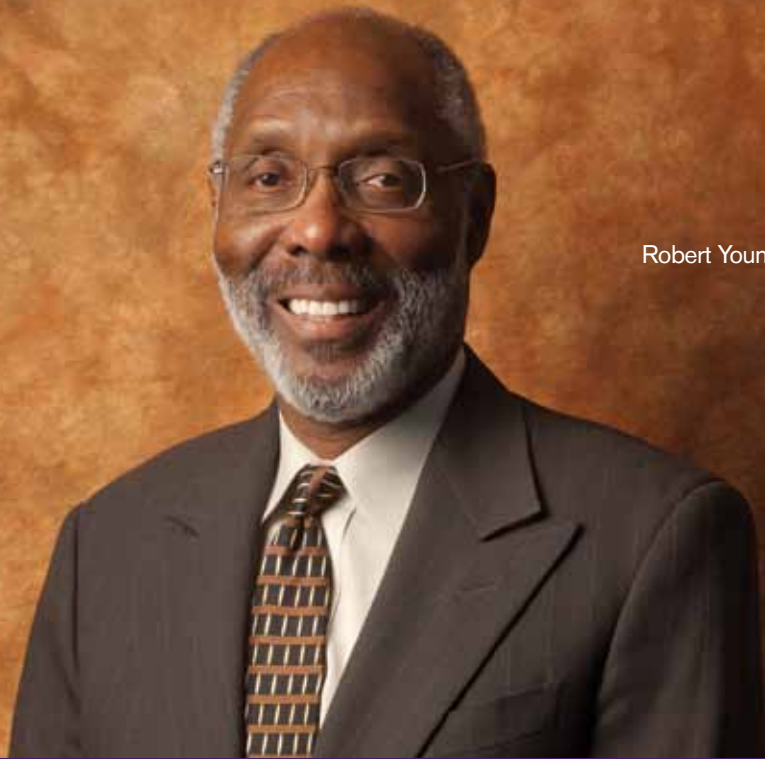
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*[Any opinions, findings, conclusions, or recommendations expressed in this chapter are those of the author and does not reflect the views of the National Science Foundation in any way.]*



Robert Young



Channel Powe



Dorothy Welington



Reggie Eccleston



Coral Evans

# Postscript: Where are the arts?

## Coral Evans, MBA Council Member – City of Flagstaff

*In addition to serving on council Ms. Evans is also the executive director of the Sunnyside Neighborhood Association, Inc, a non-profit organization that oversees specific strategies, initiatives and programs within one of the Flagstaff's most challenged neighborhoods. Ms. Evans is currently pursuing a Ph.D. in Sustainability Education and holds a Master's degree in Business Administration and a Bachelor of Science Degree in Business Management.*

We often hear America's leaders state that the US public education system is significantly flawed, and many of us agree. Interestingly, in this assumed age of enlightenment, we can make such statements without knowing America's original intent for mass education. During the Industrial Revolution, our society increasingly needed workers willing to engage in repetitive activities so that America could achieve a higher standard of living. The only way this could be accomplished on a massive scale was through a standardized educational system that supported the basic attitudes and skills business needed at that time: (a) acceptance of shift-like hours and (b) basic knowledge of the three Rs' (reading, writing, and arithmetic). When one looks at our educational system from that historical perspective, it is reasonable to conclude that public education was very successful at meeting the societal needs and expectations of the time. However, the "Machine Age", as we once knew it, has passed. In the present era of technology and globalization, we can no longer afford to be chained to an archaic approach to education—an approach intended to support a way of life that is on the brink of extinction.

The concept of why we educate and how we educate needs to be reexamined expeditiously. Not only were the original goals exclusive of African Americans, but they no longer reflect the drastically changing needs of this and future generations. Today's businesses require workers who are well-rounded, self-motivated thinkers—individuals who can function and perform outside of or even without a box. They need problem solvers with reasoning and mediation skills as well as people who are willing to partner with others to find creative solutions. Collaboration must cross racial and geographic boundaries and no longer include discriminatory practices. To accomplish these goals, we must hold "businesses' feet to the fire."

Many of us expect businesses to be ecologically minded, to practice sustainability, and to function in a way that encourages diversity of thought and practice. The gross domestic product (GDP) model is no longer a sufficient success measurement. Both the hyperproduction and hyperconsumption of material have become our Achilles' heels. One need only look at the recent Wall Street protests to understand this point. Unfortunately, not all have joined this public outcry.

Past generations have solely focused on meeting the needs of business and growing the GDP. Indeed, we were so successful at both that we can now help students earn an MBA in less than 18 months, and we have managed to export the majority of our manufacturing overseas. Currently, businesses need STEM workers. Responsively, we are riding the wave of STEM full force ahead, seemingly unaware of the cliff that is growing closer in the distance. Perhaps a focus on STEM is what is needed to get us to the edge of the cliff and beyond it.

Where else in the world is there a massive government push to educate its future generations in solely STEM disciplines? It seems interesting in a global market that fields of study including language, culture, history, philosophy, ethics, arts, and the humanities are casually discounted as if seemingly without value. We appear content to have our educational system be transmissive rather than transformative. We need people who have degrees in education to teach, but we no longer

provide scholarships for teachers. We need historians to remind us of past attempts and failures, yet history is now considered an elective class. Music, a complicated audible form of mathematics, is the first subject cut during a school board's budgeting process. Lawrence's artwork might sell for millions and Ellington's recordings may be priceless, but these world-renowned artists would be hard pressed to find employment in our schools as art or music teachers. In fact, it would be difficult to supply the needed space where they could teach, as many art and music classrooms are being converted into laboratory space. As a society, it seems we have decided that the arts no longer have value, or at least we have let business decide that for us.

Don't misunderstand me. Certainly, there is a need in our country, and throughout the world, for individuals who are educated in STEM fields, but STEM seems to have reshaped our educational system such that it now focuses on creating workers who can meet the newest business needs without regard for the past, present, or future. STEM initiatives appear eager to assist with the rebuilding of an economic system that is seemingly declining rapidly. However, I believe that as a country we will need educational endeavors that are holistic in nature if we are to be competitive at a global level—that is, education that more clearly includes the arts. But then many would say that the new STEM educational push truly reflects the client needs that public education was meant to serve. After all, what is good for business must be good for society, right?

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- <sup>1</sup> Ackoff, R. & Greenberg, D. (2008). *Turning learning right side: Putting education back on track*. Upper Saddle River, NJ: Pearson Education.

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Christopher Wahl	Manager, Creative Services
Tom Story	ASU Photographer

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Ziva Lackoff	Academic Financial Specialist Senior School of Social Transformation

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**For more information contact:**  
Kimberly A. Scott  
Arizona State University  
College of Liberal Arts and Science  
School of Social Transformation  
P.O. Box 874902, Tempe, AZ 85287-4902  
(480) 965-7174

