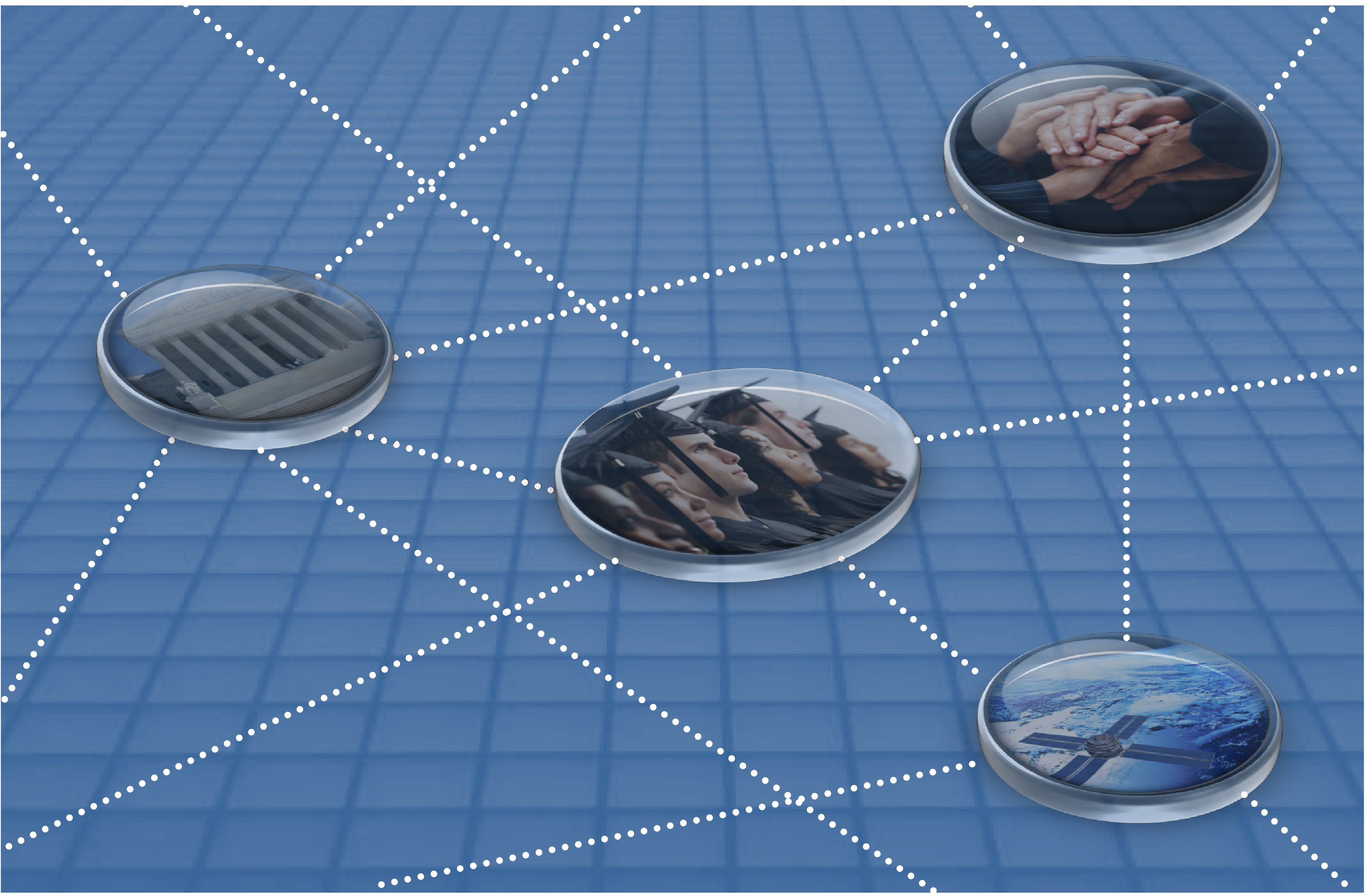
THE SMART GRID FOR INSTITUTIONS OF HIGHER EDUCATION AND THE STUDENTS THEY SERVE

Developing and Using Collaborative Agreements to Bring More Students into STEM



AAAS
ADVANCING SCIENCE, SERVING SOCIETY

EducationCounsel
POLICY LAW STRATEGY ADVOCACY

THE SMART GRID FOR INSTITUTIONS OF HIGHER EDUCATION AND THE STUDENTS THEY SERVE

Developing and Using Collaborative Agreements to Bring More Students into STEM

Produced as part of the NSF-Funded AAAS Diversity and Law Project

Arthur L. Coleman, Katherine E. Lipper, Jamie Lewis Keith, Daryl E. Chubin, and Teresa E. Taylor

AAAS
ADVANCING SCIENCE, SERVING SOCIETY

EducationCounsel
POLICY LAW STRATEGY ADVOCACY

© American Association for the Advancement of Science, 2012

This publication has been produced as part of the American Association for the Advancement of Science [AAAS] Diversity and Law Project, in which the Association of American Universities participates. More specifically, it has been produced as part of the second phase of this project that focuses on science, technology, engineering and math [STEM]-related access and diversity-related law, policy, and programmatic issues. Focused on providing institutions of higher education with in-depth legal analysis and guidance tied to program models, this second phase of work will facilitate the development and implementation of key strategies and approaches in STEM (and other) fields that can be successful because they are both effective and legally sustainable.

AAAS leads the second phase of this project with the participation of several national organizations that serve a wide range of higher education institutions, including: The American Council on Education, the Association of American Medical Colleges, the National Association of College and University Attorneys, the College Board, the American Association of Community Colleges, the Institute for Higher Education Policy, the Thurgood Marshall College Fund, the Association of Public and Land-Grant Universities, and the primary funder of phase one of the project, the Alfred P. Sloan Foundation. The Association of American Universities continues as an inaugural participant.

Project leadership has been provided by Dr. Daryl Chubin, Director of the AAAS Center for Advancing Science & Engineering Capacity, and Jamie Lewis Keith, Vice President and General Counsel of the University of Florida, both Co-Project Directors; and Art Coleman, Managing Partner of EducationCounsel LLC, Project Counsel. Dr. Shirley M. Malcom, Head, Education and Human Resources Programs, AAAS, has also provided policy advice and support. An advisory board, co-chaired by Bob Burgoyne and Columbia Law School Professor Theodore Shaw of Fulbright and Jaworski, LLP, has offered overall expert input and guidance. EducationCounsel LLC has provided policy, legal, and overall support for phase two of the project, with principal assistance from Katherine Lipper.

These materials represent the views and analyses of the authors and contributors, and do not necessarily reflect the views or analyses of the American Association for the Advancement of Science, the Association of American Universities, the Alfred P. Sloan Foundation, the National Science Foundation, the University of Florida, or any participating institution, organization, or representative attending any related workshop or contributing to the project. AAAS acknowledges the generous support of the Alfred P. Sloan Foundation, which funded the 2009-2010 workshops and preparation of all materials through multiple awards (2007-5-51 UGSP, B2008-52, 2008-5-35 UGSP, and 2009-5-33 UGSP) and the National Science Foundation (NSF), which provided supplementary funding in 2009-2010 and is funding the second phase of the project (HRD-1038753). Special thanks to Sabira Mohamed of AAAS for assistance in producing this publication.

The Smart Grid and other project resources are available for free downloading at http://php.aaas.org/programs/centers/capacity/publications/complexlandscape/. Project resources may be copied and adapted for internal use by public and tax-exempt private institutions of higher education.

Cover Design: Sabira Mohamed, AAAS Center for Advancing Science & Engineering Capacity

© American Association for the Advancement of Science, 2012

About the Authors

Arthur L. Coleman **is managing partner of EducationCounsel, LLC; he served as deputy assistant secretary for civil rights and senior policy advisor to the assistant secretary for civil rights in the U.S. Department of Education from 1993 to 2000.**

Katherine E. Lipper **is a policy and legal advisor at EducationCounsel. A former seventh grade English and reading teacher, she focuses on the issues of access and diversity in elementary, secondary, and higher education.**

Jamie Lewis Keith **is Vice President and General Counsel of the University of Florida. She was Senior Counsel (primary inside counsel) of the Massachusetts Institute of Technology from 1999 to 2006.**

Daryl E. Chubin **is Director of the AAAS Center for Advancing Science & Engineering Capacity at the American Association for the Advancement of Science, which he established in 2004. His career extends from faculty member in four universities to federal staff in the legislative and executive branches of government to nonprofit executive. He is the author of eight books and numerous reports.**

Teresa E. Taylor **is the Education Pioneers Fellow at EducationCounsel as she completes her law degree at Georgetown University. She is the daughter of successful mechanical engineer who transitioned from a community college to a research institution.**

The authors express their gratitude for the guidance of Melinda Grier and Demaree Michelau, whose insights significantly informed this document.

The American Association for the Advancement of Science (AAAS) is the world's largest general scientific society and publisher of the journal Science (www.sciencemag.org). AAAS was founded in 1848 and includes some 262 affiliated societies and academies of science, serving 10 million individuals. The non-profit AAAS (www.aaas.org) is open to all and fulfills its mission to "advance science and serve society" through initiatives in science policy; international programs; science education; and more. The AAAS Center for Advancing Science & Engineering Capacity provides institutions of higher education with assistance in improving delivery of their educational mission. The Center works to improve campus climate and increase recruitment, retention, and advancement of U.S. students and faculty in STEM fields, especially those from traditionally underrepresented groups.

EducationCounsel, LLC, is an innovative law, policy, strategy, and advocacy organization committed to strengthening education systems, closing achievement gaps, and expanding access to educational opportunities. The firm collaborates with education leaders from across the country, including state and local leaders, higher education officials, associations, foundations, and pioneering private and public entities to improve educational outcomes for all students. EducationCounsel's higher education work centers on policy and legal issues associated with access and diversity, as well as college completion. It also counsels and advocates for clients on issues of federal legal compliance (with a focus on non-discrimination and accreditation issues). EducationCounsel is an affiliate of Nelson Mullins Riley & Scarborough, LLP, a national law firm of over 400 attorneys who serve clients on issues relating to complex litigation, corporate services, intellectual property, employment, government relations, regulatory, and more. For more information, please visit www.educationcounsel.com.

© American Association for the Advancement of Science, 2012

TABLE OF CONTENTS

© American Association for the Advancement of Science, 2012

What is the Smart Grid?

To aid understanding of the paper's central metaphor, this paper adopts a running comparison between the electrical Smart Grid and the Smart Grid for institutions of higher education and the students they serve.

The traditional electric grid relied on one method of electricity delivery for all electricity users. As demands on the system increase, however, the "one size fits all" approach is no longer sustainable. Instead, power generator and distributors have to work with power users to determine when and where electricity is needed, and how best to meet those needs. By contrast, the electrical Smart Grid is a nationally-focused project which seeks to modernize the aging electrical grid with automated systems, data input, and better planning. The success of the Smart Grid depends on local and regional efforts to adopt systems that, in this context, work for them. And even small changes can have significant results: if the current grid were just 5% more efficient, the energy savings would equate to the permanent removal of fuel and greenhouse gas emissions from 53 million cars.

Correspondingly, the current system of higher education is struggling to respond properly to the array of challenges presented by an increasingly diverse group of students. Institutions have to innovate and adapt to produce better outcomes for students as well as ensure their own institutional livelihood and the country's well-being. Thus, the Institutional Smart Grid connects existing institutional resources through individualized collaborative agreements to build America's science, technology, engineering, and mathematics (STEM) workforce and academic programs. In the metaphor, the "energy" consists of STEM opportunities and contributions by STEM graduates to U.S. and global innovation, economic growth, and national security. Institutions of higher education are the "generators" and "distributors" that ensure that the STEM energy flows to the right "users" – students of all backgrounds as well as U.S. industrial and economic actors. Collaborative agreements help institutions increase accessibility and adapt the delivery of their STEM resources to a larger and broader pool of students.

Background and Overview

The present day reality. The 21st Century has begun with a host of continuing and new national security, economic, and social challenges for America. Institutions of higher education have never been more central to our national agenda as they address these issues in their education of a new generation of students—students who will spark innovation, productivity and new ways of thinking. To do their part in this national effort, institutions of higher education are constantly challenged to do more (with less) for the foreseeable future—and to do so in the midst of stark demographic, technological, and economic changes.

© American Association for the Advancement of Science, 2012

The backdrop for meeting the challenge is starkly clear: Enrollment in degree-granting institutions has steadily increased over the last 20 years,[1] even as degree attainment levels have remained at middling to low levels.[2] Correspondingly, despite gains in enrollment and attainment levels for historically under-served populations of students in STEM fields,[3] significant gaps in STEM academic programs persist:

- White men dominate the aging American science and engineering workforce[4] and far fewer current female undergraduates pursue STEM majors and earn STEM degrees compared to their male counterparts (even though women now make up more than half of all undergraduates).[5]

- Both African-Americans and Hispanics earn a significantly smaller number of STEM degrees (especially advanced degrees) compared to their share of the population. Minority women's share is especially small.[6]

- Non-U.S. citizens earn three times as many STEM master's degrees[7] and four times as many STEM doctoral degrees[8] at U.S. institutions as all other minority groups combined.

---

[1] Enrollment in degree-granting institutions increased by 14% between 1987 and 1997. Between 1997 and 2007, enrollment increased by 26%, from 14.5 million to 18.2 million students. The number of full-time students rose 34%, while the number of part-time students rose 15%. U.S. Dep't of Education, Nat'l Ctr. for Educ. Statistics, *Fast Facts: Enrollment,* http://nces.ed.gov/fastfacts/display.asp?id=98. Nat'l Ctr. for Educ. Statistics, U.S. Dep't of Educ.. *Digest of Education Statistics, 2010* (NCES 2011-015) (2011).

[2] Fifty-seven percent of first-time students who enrolled at four-year institutions in the fall of 2002 and sought a BA or BS completed their degrees within six years – just two percentage points higher than the degree attainment rate of the analogous 1996 cohort. At two-year institutions, just 27% of first-time, full-time students who enrolled in the fall of 2005 completed a certificate or associate's degree within 150% of the normal time required to complete such credentials – two percentage points less than the cohort enrolled in 1999. Nat'l Ctr. for Educ. Statistics, U.S. Dep't of Educ., (2011). *The Condition of Education 2011* (NCES 2011-033), http://nces.ed.gov/programs/coe/indicator_pgr.asp.

[3] These underserved groups include women, Hispanic and Latino Americans, African-Americans, Native Americans, Alaskan Natives, Hawaiian Natives, and Pacific Islanders. Though other populations of Asian-Americans are well represented in STEM fields, many data sets lump Alaskan Natives, Hawaiian Natives, and Pacific Islanders into the broader "Asian-American" category.

[4] Nat'l Sci. Found., Women, Minorities, and Persons with Disabilities in Science & Engineering (Feb. 2011), Occupation (http://www.nsf.gov/statistics/wmpd/digest/theme4.cfm.

[5] U.S. Dep't of Educ., Nat'l Ctr. for Educ. Statistics, Beginning Postsecondary Students (2009) (hereinafter BPS:2009).

[6] *Id.*

[7] U.S. Dep't of Educ., Nat'l Ctr. for Educ. Statistics, Digest of Education Statistics, Table 300: Master's degrees conferred by degree-granting institutions, by sex, race/ethnicity, and field of study: 2008-09 (Sept. 2010), http://nces.ed.gov/programs/digest/d10/tables/dt10_300.asp,

[8] U.S. Dep't of Educ., Nat'l Ctr. for Educ. Statistics, Digest of Education Statistics, Table 303: Doctor's degrees conferred by degree-granting institutions, by sex, race/ethnicity, and field of study: 2008-09 (Sept. 2010), http://nces.ed.gov/programs/digest/d10/tables/dt10_303.asp,

© American Association for the Advancement of Science, 2012

What does all of this mean? Aside from the obvious answer that there are no silver bullets, it is clear that higher education institutions must continue to pursue new strategic and systemic ways of thinking and adopt multiple strategic efforts. By finding new ways to improve America's education system and help more students earn the credentials required for the 21st Century, the United States can assert its place as "the world's engine of scientific discovery and technological innovation."[9] To be successful, institutions of higher education must attract and meet the needs of students who are increasingly diverse, mobile,[10] and reliant on transition pathways between schools.

"This paper addresses the development of voluntary educational collaborations between institutions of higher education to expand the pipeline for all students – including but not limited to women, non-Asian minorities, and students from low socio-economic backgrounds – into progressively higher levels of STEM education."

The Smart Grid focus. This paper addresses the development of voluntary educational collaborations between institutions of higher education to expand the pipeline for all students – including but not limited to women, non-Asian minorities, and students from low socio-economic backgrounds – into progressively higher levels of STEM education. Such action is an imperative for the United States in view of demographic trends, student needs, and economic and national security demands.

This paper centers on the promise of change that can be advanced by institutional efforts to develop new institutionally-driven, collaborative relationships tailored to the specific needs of institutions, students, and STEM fields. With such a focus, colleges and universities can systematically expand sustainable opportunities for student transition, with corresponding exchanges of resources and the introduction of new talent to existing programs. Within the context of each institution's own goals for an educational collaboration in STEM fields, institutions can pursue legally sustainable objectives to increase the participation in STEM higher education of students of all races, genders, and socio-economic backgrounds.

This paper expounds on the key elements of voluntary,[11] institution-based collaborative agreements that can facilitate the expansion of student pathways,[12] as well as key elements of promising collaborative relationships in STEM programs. As the information and guidance

---

[9] President Barack Obama, Remarks by the President on the "Educate to Innovate" Campaign (Nov. 23, 2009), http://www.whitehouse.gov/the-press-office/remarks-president-education-innovate-campaign.

[10] About one third of postsecondary students transferred to a different institution at least once. BPS: 2009.

[11] In this context, "voluntary" means not government-mandated.

[12] Collaborative agreements can take many forms, ranging from single department exchange programs to statewide, government-mandated articulation agreements. This paper focuses on voluntary educational collaboration models that foster transitions for students through progressive levels of educational attainment rather than government-mandated articulation agreements.

© American Association for the Advancement of Science, 2012

provided in these sections reflects, different institutions may find some sections of this paper to be of more or less relevance, depending on their experience in these issues, as well as their present goals and circumstances.

The Smart Grid structure. Following this background and overview section:

- **Section I** provides a brief summary of the relevant demographic picture, illustrative of current barriers to student achievement and attainment in STEM fields.

- **Section II** provides a conceptual introduction and framework for thinking through the key issues associated with successful collaborative arrangements among institutions of higher education. As it explains, although collaborative agreements can and should be structured according to the strengths and needs of the institutions and the students they seek to serve, common questions integral to success must be addressed, including the identification of institutional and student needs, clarity of purpose for the collaboration, and effective inclusion of relevant stakeholders when developing policies and agreements.

- Building on the framework of Section II, **Section III** outlines several structural models for collaborative affiliations, including those between two-year and four-year institutions, between four-year institutions, and between undergraduate and graduate programs. Tied to a common set of inquiries, each of these models is presented in light of relevant contextual differences, including different kinds of institutions and student populations.

- **Section IV** rounds out the substance of relevant key issues with an overview of important supplementary strategies and policies that can be instrumental as part of an overall institutional plan for facilitating and enhancing student transitions in STEM fields. These include institutional capacity-building measures, student STEM skills development programs, and programs designed to help increase the likelihood of graduation.

"This paper builds on a body of significant research and work that has largely focused on state-based articulation systems. It also represents a first: guidance for private and public institutions of higher education alike (and departments within these institutions) to consider as they evaluate ways in which to collaborate voluntarily and develop their contributions to the Smart Grid."

This paper builds on a body of significant research and work that has largely focused on state-based articulation systems. It also represents a first: guidance for private and public institutions of higher education alike (and departments within these institutions) to consider as they evaluate their own customized ways to collaborate

© American Association for the Advancement of Science, 2012

voluntarily and develop their contributions to the Smart Grid. The authors hope that it will aid many institutions of higher education to strengthen their contributions to higher education in STEM and the 21st Century workforce in innovative, effective ways.

© American Association for the Advancement of Science, 2012

Key Terms

Collaborative agreement
This paper's term for a flexible, institution-driven agreement that creates new academic pathways for students through progressive educational levels
Related terms include:

- ***Articulation*** As commonly understood, a formal, often state-mandated policy between two or more institutions specifying how credits earned at one institution will be accepted by another toward its degree program.
- ***2+2 program*** Transfer system through which students who earn a 2-year associate degree may receive junior status and admission at a four-year institution.
- ***3+2 agreement*** Dual degree program in which students spend 3 years at one institution and 2 years at another to earn degrees from both. Engineering 3+2 programs are particularly popular.

Receiving institution
College or university that accepts transitioning students into its degree programs.

Transferring institution
College or university at which a student takes some classes or earns a credential or degree but does not earn the final element of his or her degree program.

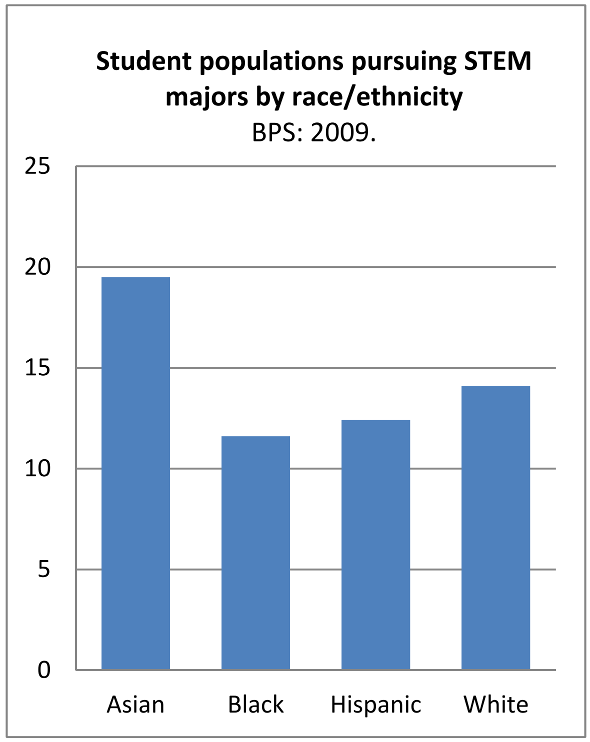
Four-year institution
Institution that grants a majority of its undergraduate degrees at the baccalaureate level**.**

Two-year institution
Institution that grants a majority of its degrees at the associate's level (this includes institutions grant some four-year degrees in applied fields).

© American Association for the Advancement of Science, 2012

Section I. *The Energy Supply:* STEM Fields and the Challenges to Student Achievement

Achievement and degree attainment in STEM fields depends on commitment and hard work by individual students as well as proper academic foundations laid during primary and secondary school. Disparities in K-12 education in science and math – particularly in minority- and poverty-concentrated districts – mean that some students start off farther behind.[13] Moreover, students from different backgrounds tend to perform differently in college – even if they share the same academic background and postsecondary environment.[14] This variance suggests that institutional culture, policies, and programs matter,[15] particularly in light of persistent elementary and secondary trends and performance gaps. Demographic trends within STEM are not likely to change without institutional action to increase sustained interest and success in STEM fields.



[13] An estimated three-fifths of students in public two-year and one-quarter of students in public four-year institutions require at least one year of remedial education. GEORGE KUH ET AL., COMMISSIONED REPORT FOR THE NATIONAL SYMPOSIUM ON POSTSECONDARY STUDENTS: SPEARHEADING A DIALOG ON STUDENT SUCCESS 2 (2006), http://nces.ed.gov/npec/pdf/kuh_team_report.pdf.

[14] Having a lower socio-economic status, for example, has a strong correlation with a lessened probability of degree completion. *Id.*; THOMAS BAILEY, D. TIMOTHY LEINBACH, & DAVIS JENKINS, CCRC BRIEF NO. 28: GRADUATION RATES, STUDENT GOALS, AND MEASURING COMMUNITY COLLEGE EFFECTIVENESS (2005), http://ccrc.tc.columbia.edu/DefaultFiles/SendFileToPublic.asp?ft=pdf&FilePath=c:\Websites\ccrc_tc_columbia_edu_documents\332_336.pdf&fid=332_336&aid=47&RID=336&pf=ContentByType.asp?t=1.

[15] African-American and Hispanic community college students who take remedial courses are much less likely than their peers who do not need remediation to complete their degrees or transfer to a four-year school within six years. White community college students, in contrast, tend to have similar degree completion and transfer rates regardless of whether they are enrolled in remedial courses. And Native American students tend to pursue degrees at four-year institutions at *higher* rates if they first attend a Tribal college. *Id.; see also* Lindsey E. Malcom & Shirley M. Malcom, *The Double Bind: The Next Generation*, 81 HARV. EDUC. R. 162, 164 (2011).

© American Association for the Advancement of Science, 2012

The Smart Grid: Connecting All Users to the Grid

Like electricity flowing from power generators and distributors to individual users, STEM disciplines energize individual students by giving them new and often unexpected academic and career prospects. In turn, these students use this energy to spur economic development and innovation and enhance national security. Ensuring that STEM opportunities reach all potential students has long been an issue, though not necessarily a problem that institutions have been able to remedy acting alone. Institutions must identify gaps in access to STEM recruitment and retention but they must do more than that. Institutional leadership must identify where gaps exist and where internal and external collaborative opportunities await to expand access and help close the identified gaps.

Broadly speaking, STEM disciplines lack diversity in gender and race and ethnicity. Women and underrepresented minorities make up about two-thirds of the nation's workforce – and together they are the fastest growing segments of the U.S. college-age population. Despite this reality, women and underrepresented minorities make up only about one quarter of the STEM workforce.[16] While 21.6% of male students pursue STEM majors, only 8% of female students do.[17] Just 11.6% of black students and 12.4% of Latino students pursue STEM degrees, compared to 14% of white students and 19.5% of Asian students.[18] Black and Latino students earn only 16.7% of baccalaureate degrees in STEM fields.[19] This is more troubling considering that fewer black and Latino students pursue postsecondary education in the first place,[20] while Latinos represent nearly all of the growth among school-aged children in the last decade.[21]

[16] WORKFORCE/EDUC. SUBCOMMITTEE, PRESIDENT'S COUNCIL OF ADVISORS ON SCI. AND TECH., SUSTAINING THE NATION'S INNOVATION ECOSYSTEM: REPORT ON MAINTAINING THE STRENGTH OF OUR SCIENCE & ENGINEERING CAPABILITIES 6 (2004), http://www.whitehouse.gov/sites/default/files/microsites/ostp/pcast-04-sciengcapabilities.pdf.

[17] BPS: 2009.

[18] *Id.*

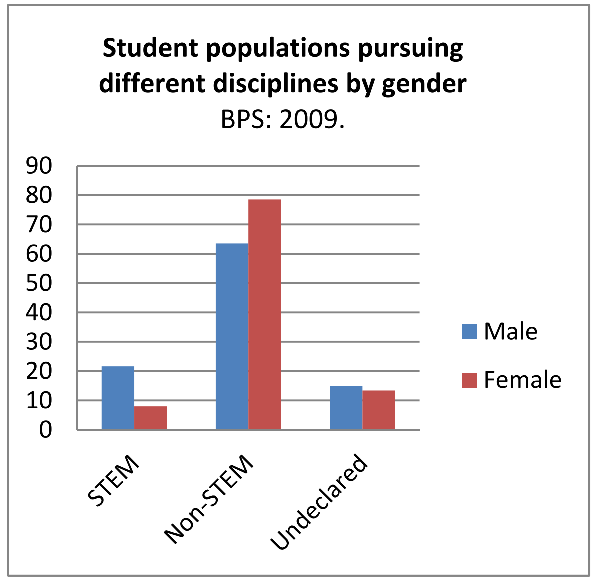
[19] Nat'l Sci. Found., Science and Engineering Degrees by Race/Ethnicity: 1997-2006 t.4, NSF 10-300 (2008), http://www.nsf.gov/statistics/seiind08/c2/c2s4.htm#c2542.

[20] As of 2008, only 41.6% Americans ages 25 to 34 had attained an associate degree or higher. Only 30.3% of African Americans and 19.8% of Latinos in that age group had attained an associate degree or higher, compared to 49% of white students and 70.7% of Asian students. JOHN MICHAEL LEE JR. & TATAYA RANSOM, COLLEGEBOARD ADVOCACY & POLICY CTR., THE EDUCATIONAL EXPERIENCE OF YOUNG MEN OF COLOR: A REVIEW OF RESEARCH, PATHWAYS AND PROGRESS 9 (2011), http://youngmenofcolor.collegeboard.org/sites/default/files/EEYMC-ResearchReport_0.pdf.

[21] Latino children make up nearly one in four of school-aged children in the United States today. Between 2000 and 2009, the number of Latino school-aged children rose 34.6%, while the number of white children declined 7.4% and the number of black children fell 2.4%. Kids Count Data Ctr., Nat'l Kids Count Program, Child population by race (updated Dec. 2010), http://datacenter.kidscount.org.

© American Association for the Advancement of Science, 2012

The higher education system also fails to reach many promising but economically disadvantaged students. Almost 600,000 students graduate from the top half of their high school class and do not earn a degree within eight years– and a majority of these students come from economically disadvantaged families.[22] The proportion of low-income community college transitioning students in entering classes of elite institutions is less than 0.1%. [23] These students are also underrepresented in less selective institutions – just 22% of students at such institutions come from the bottom two socio-economic status quintiles.[24] Low representation within higher education generally means that students from economically disadvantaged backgrounds are missing in STEM fields as well.



Meeting the challenges of STEM education in the United States requires a close look at current demographic realities related to STEM. Nationally, significant differences exist not only between STEM and non-STEM disciplines but also among individual STEM disciplines. A few promising trends exist, but STEM disciplines remain deficient in nearly every measure of diversity – gender, race and ethnicity, propensity to transfer, socio-economic status, and family educational background. Table 1 compares key student demographic statistics for each STEM discipline with the overall undergraduate population. As institutional actors review these national demographics, they should consider how their own student populations are represented in STEM fields and whether they have the institutional data to make that analysis.

[22] More than 400,000 of these students come from families who make less than $85,000 a year; half of these come from families who make less than $50,000 a year; and more than 80,000 come from families with incomes below $30,000. Anthony Carnevale & Jeff Strohl, *How Increasing College Access is Increasing Inequality, and What to Do About It*, *in* REWARDING STRIVERS 71, 93 (Richard D. Kahlenberg, ed., 2010); *see also* Sabrina Tavernise, *Education Gap Grows Between Rich and Poor*, N.Y. TIMES (Feb. 9, 2012), http://www.nytimes.com/2012/02/10/education/education-gap-grows-between-rich-and-poor-studies-show.html.

[23] Alicia C. Dowd, John J. Cheslock, & Tatiana Melguizo, *Transfer Access from Community Colleges and the Distribution of Elite Higher Education*, 79 J. HIGHER EDUC. 442, 461-62 (2008).

[24] *Id.*

© American Association for the Advancement of Science, 2012

Table 1: Demographic Differences Among Students in STEM Disciplines[25]					
Discipline	**Gender**	**Race/Ethnicity**	**Students transferring at least once**	**Students below the poverty line**	**1st generation college students**
All academic disciplines (STEM and non-STEM)	*57.5% female*	♦ *13.8% Black* ♦ *14.9% Hispanic* ♦ *0.6% American Indian*	*31.7%*	*19.8%*	*46.7%*
Biological sciences	58.9% female	♦ 8.5% Black ♦ 6.6% Hispanic ♦ 0.5% American Indian	25%	13.1%	21.5%
Computer and Information Science	19.2% female	♦ 16.2% Black ♦ 8.1% Hispanic ♦ 0% American Indian	44.5%	16.2%	41.5%
Engineering	13.9% female	♦ 7.1% Black ♦ 13.7% Hispanic ♦ 0% American Indian	30.3%	13.2%	24%
Mathematics and Statistics	56.3% female	♦ 2.0% Black ♦ 5.5% Hispanic ♦ 0% American Indian	25.9%	7.8%	26.4%
Physical Sciences	44.4% female	♦ 9.6% Black ♦ 4.3% Hispanic ♦ 0.4% American Indian	40.8%	10.8%	19.4%

With these demographic realities in mind, it comes as little surprise that the STEM workforce largely consists of white men, who make up 55% of professionals in science and engineering fields.[26] This workforce, however, is aging: 26% of STEM workers were older than 50 in 2006.[27] And not enough new graduates who are U.S. citizens are available to replace these workers and

[25] BPS: 2009.

[26] White women make up 18% of science and engineering professionals, Asian men 12%, Asian women 5%, Hispanic men 3%, Black men 2%, Other men 2%, and each group of non-Asian minority women making up 1% or less. Nat'l Sci. Found., Occupation , Women, Minorities, and Persons with Disabilities in Science & Engineering (Feb. 2011), (http://www.nsf.gov/statistics/wmpd/digest/theme4.cfm.

[27] NAT'L SCI. BD., SCI. AND ENG'G INDICATORS 2010, at Ch. 3, *Science and Engineering Labor Force*, http://www.nsf.gov/statistics/seind10/c3/c3h.htm.

© American Association for the Advancement of Science, 2012

sustain the strong STEM sector growth rate.[28] Few American students choose to major in STEM fields and fewer still stick with their STEM major to graduation.[29] Only 32% of baccalaureate degrees earned in the United States are in STEM fields[30] and significant numbers of students in STEM advanced degree programs students are not U.S. citizens.

> ***"As former U.S. Secretary of Education Richard W. Riley has explained, 'Today, we are educating for jobs that may not yet exist, and technologies that haven't been invented, to solve problems that we can't yet conceive.'"***

The innovations produced by STEM fields will cause the economy and workforce of tomorrow to look much different from that of today. As former U.S. Secretary of Education Richard W. Riley has explained, "Today, we are educating for jobs that may not yet exist, and technologies that haven't been invented, to solve problems that we can't yet conceive."[31] The American economy has shifted from an industrial to a knowledge, technology, and service-based economy, and STEM fields remain an essential driver of the nation's economic success.[32] Scientists and engineers comprise about 4% of the U.S. workforce,

---

28 ANTHONY CARNEVALE, NICOLE SMITH, & MICHELLE MELTON, STEM 9 (2011), http://www9.georgetown.edu/grad/gppi/hpi/cew/pdfs/stem-complete.pdf ("We conclude that our education system is not producing enough STEM-capable students to keep up with demand both in traditional STEM occupations and other sectors across the economy that demand similar competencies. The demand for STEM competencies outside STEM occupations is strong and growing.").

29 A six-year study of students at a large Midwestern university with very high research activity showed that 73% of students who started in a STEM major remained in a STEM major, while 92% of students who started in a non-STEM major remained in those disciplines. Donald F. Whalen & Mack C. Shelley, II, *Academic Success for STEM and Non-STEM Majors*, 11 J. STEM EDUC. 45, 51 (2010).

30 In contrast, 53% of baccalaureate degrees in China and 63% in Japan are earned in STEM fields. NAT'L SCI. BD., SCI. AND ENG'G INDICATORS 2010, at Appendix Table 2-35, http://www.nsf.gov/statistics/seind10/append/c2/at02-35.pdf.

31 Richard W. Riley, *Foreword to* ARTHUR L. COLEMAN, FRANCISCO M. NEGRÓN, JR., & KATHERINE E. LIPPER, NAT'L SCH. BDS. ASS'N, COLLEGE BD., & EDUCATIONCOUNSEL, LLC, ACHIEVING EDUCATIONAL EXCELLENCE FOR ALL: A GUIDE TO DIVERSITY-RELATED POLICY STRATEGIES FOR SCHOOL DISTRICTS 4 (2011); *see also* Virginia Heffernan, *Education Needs a Digital-Age Upgrade*, N.Y. TIMES OPINIONATOR (Aug. 7, 2011, 5:30 pm), http://opinionator.blogs.nytimes.com/2011/08/07/education-needs-a-digital-age-upgrade/?ref=opinion&nl=opinion&emc=tya1 (quoting the co-director of the annual MacArthur Foundation Digital Media and Learning Competitions' belief that 65% of the work current elementary school children will do as adults has not been invented yet).

32 Consider that STEM workforce growth has outstripped significantly the expansion of the American workforce as a whole. Between 1950 and 2000, the average growth per decade was 51.4% in the STEM workforce and 18% for the overall workforce. LINDSAY LOWELL & MARK REGETS, A HALF-CENTURY SNAPSHOT OF THE STEM WORKFORCE, 1950-2000 4-5 (2006), http://www.cpst.org/STEM/STEM_White1.pdf. Recent STEM workforce growth has been more modest, but was still twice as high as the overall workforce growth rates. Between 2004 and 2007, the STEM workforce averaged 3.2% annual growth, while the rest of the U.S. workforce only grew about 1.5%. NAT'L SCI. BD., SCIENCE AND ENG'G INDICATORS 2010, at Ch. 3, *Science and Engineering Labor Force*, http://www.nsf.gov/statistics/seind10/c3/c3h.htm.

© American Association for the Advancement of Science, 2012

but they help generate jobs for the other 96% through research and discovery.[33] Moreover, solutions for the most serious modern challenges, including those we can't yet envision – cures for disease, energy generation, environmental preservation, and economic development – are found within STEM fields.

To solve these problems, students need to acquire the necessary skills and credentials to understand and contribute to STEM and STEM-dependent disciplines. In 1983, almost 83% of STEM employees had at least some postsecondary education; by 2008, that number climbed to 92% and is projected to remain there through 2018.[34] Nine out of the ten fastest-growing occupations that require at least a bachelor's degree will require significant scientific or mathematical training.[35]

The country needs its institutions of higher education to attract, retain, and graduate as many STEM students as possible – and, simply put, current programs are not cutting it. To reach and meet the needs of today's diverse population of students, institutions must be innovative in their approach. Collaborative relationships between institutions can help them be just that.

"The country needs its institutions of higher education to attract, retain, and graduate as many STEM students as possible – and current programs are not cutting it. To reach and meet the needs of today's diverse population of students, institutions must be innovative in their approach. Collaborative relationships between institutions can help them be just that."

[33] NAT'L ACADS., RISING ABOVE THE GATHERING STORM, REVISITED: RAPIDLY APPROACHING CATEGORY 5 2-3 (2010), http://www.nap.edu/catalog.php?record_id=12999 ("Importantly, leverage is at work here. It is not simply the scientist, engineer and entrepreneur who benefit from progress in the laboratory . . . [I]t is also the factory worker . . . the advertiser . . . the truck driver . . . the salesperson . . . the maintenance person . . . not to mention the benefits realized by the user [of new technological discoveries].").

[34] ANTHONY CARNEVALE, NICOLE SMITH, & JEFF STROHL, HELP WANTED: PROJECTIONS OF JOBS AND EDUCATION REQUIREMENTS THROUGH 2018 52 (2010), http://www9.georgetown.edu/grad/gppi/hpi/cew/pdfs/FullReport.pdf.

[35] BUREAU OF LABOR STATISTICS, U.S. DEP'T OF LABOR, FASTEST GROWING OCCUPATIONS (Dec. 8, 2010), http://www.bls.gov/emp/ep_table_103.htm.

© American Association for the Advancement of Science, 2012

The Legal Landscape

Questions of law are not far removed when issues of promoting access and diversity are present – and this is particularly true when those issues require a focus on race-, ethnicity- and gender-related access and diversity policies. The array of strategies available that merit consideration in the pursuit of access and diversity goals range from those that are race-, ethnicity-, and gender-conscious (which raise significant legal issues) to those that are neutral (with substantially more relaxed rules).

The kinds of collaborations described in this document are aimed at expanding the STEM pipeline and serving the nation's need for a STEM workforce without granting preferences to individuals on the basis of race or gender. They should, as a consequence, be viewed as inclusive and neutrally-oriented—with a focus on enhancing science and mathematics preparation, enhancing interest in STEM careers, and facilitating transitions into progressively higher levels of STEM education for intellectually capable students who otherwise would lack the preparation or interest to enter or progress through STEM educational programs.

Consequently, the collaborations contemplated in this document can be suitable for use by any interested college or university (even if located in a state that prohibits consideration of race, ethnicity, and gender in admissions). Stated differently, institution-led collaborations such as those contemplated in this paper do not require an institution to take race, ethnicity, or gender into account when admitting students. They may, however, provide the ancillary benefit of increasing applications and admission of qualified and presently under-represented populations of students in STEM disciplines.

For more background including relevant laws and comprehensive analysis, see SUMMARY AND HIGHLIGHTS OF THE HANDBOOK ON DIVERSITY AND THE LAW: NAVIGATING A COMPLEX LANDSCAPE TO FOSTER GREATER FACULTY AND STUDENT DIVERSITY IN HIGHER EDUCATION (2d ed.) (2012); AMERICAN ASSOCIATION FOR THE ADVANCEMENT OF SCIENCE, HANDBOOK ON DIVERSITY AND THE LAW: NAVIGATING A COMPLEX LANDSCAPE TO FOSTER GREATER FACULTY AND STUDENT DIVERSITY IN HIGHER EDUCATION (2010).

© American Association for the Advancement of Science, 2012

Section II. *Improving Generation and Distribution:* The Conceptual Framework for Collaborative Agreements

A. **Choosing to Collaborate: Basic Considerations and Questions**

Collaborative agreements present a significant opportunity for academic institutions to educate more students in STEM fields without having to make costly new investments. Moreover, because collaborative agreements are flexible, institutions can structure them according to their unique character, needs, resources, and circumstances and can leverage the resources of others. Many elite research universities, for example, have top STEM research facilities but lack student diversity in STEM programs. Meanwhile, many community colleges and smaller four-year schools have the diversity and provide opportunities for supplementary education to students' K-12 science and math preparation, but often lack sophisticated STEM programs or facilities. Many kinds of institutions are seeking to address gaps and deficits in the broad student diversity they need to fulfill their educational, service, and research missions. What if these institutions tried working together instead of attempting to meet institutional and student needs on their own?

> ***"Many kinds of institutions are seeking to address gaps and deficits in the broad student diversity they need to fulfill their educational, service, and research missions. What if these institutions tried working together instead of attempting to meet institutional and student needs on their own?"***

This section explains how institutions may conceptualize collaborative arrangements with guidance on the agreement-development process, starting with an institution's initial needs assessment through the joint signing of the agreement.

© American Association for the Advancement of Science, 2012

The Smart Grid: Meeting Growing Demand

Within traditional electrical grids, energy generators and distributors mete out energy in standardized units. This system does not account for differences between individual energy users, nor does it help redirect resources when the system is overworked. The Smart Grid uses data, computer systems, and thoughtful networking to help the generators and distributors respond more effectively to user needs.

Colleges and universities work much like these energy entities as they attract, prepare, and deploy students to the STEM workforce and academia. Traditionally, most American students matriculated to and graduated from a single institution. Institutional networks were not as necessary because student need and demand for transfer was not high. Like energy consumers, however, today's students are demanding more: they seek special programs to prepare for admission to four-year institutions, support for transitions from two-year to four-year institutions, and help to progress to graduate school. To adapt the traditional system to the needs of today, colleges and universities must seek new strategies and innovative solutions.

Collaborative agreements can exist in many forms and institutions have several structuring and programmatic options. Every collaborative relationship is unique.[36]

In the context of institutional and programmatic distinctions, a number of common considerations and questions related to sustainable collaborative agreements and relationships merit attention. They include:

1. Goals
    a. What are the institutions' goals for their collaboration and how are the goals tied to each institution's mission? Do they know or do they need a pilot period to explore compatibility? How will success be measured (quantitatively or through a process and qualitative academic judgment)?
    b. How do the academic characters, qualities, and policies of potential collaborating institutions compare? If one institution offers a more competitive or more extensive academic program than the other, do the institutions have complementary goals for student transition? If so, how can the institutions align academic content, recruitment programs, and counseling services to enhance the likelihood that students can transition successfully from the first to the second institution?

[36] Several institutions, particularly those in public systems, use the term "articulation" to refer to any agreement that facilitates student transfer and the recognition of credits earned at one institution by a receiving school. Because this paper examines and promotes all forms of institutional collaboration in STEM fields, it does not rely on the term "articulation," though the discussion certainly applies to those schools in articulation systems. For definitions of these terms, see Key Terms on page 10.

© American Association for the Advancement of Science, 2012

   c. Are the student constituencies served by the institutions similar or complementary? Is there a way for both institutions to capitalize on their respective students' demographics?

2. Admissions Policy
   a. If the receiving institution is conferring a degree, will assessment of merit include a weighted credit for reaching a certain level of attainment at the transferring institution so that admissions for students from the transferring school are by preference or guarantee? Or will admissions be based on traditional assessments of the merits of each individual applicant? Even if admission to the receiving institution is assessed for each individual applicant, how can institutions enhance the likelihood of success of the transferring institution's students?
   b. If the receiving institution is not conferring a degree, will students from the transferring school have access to course offerings, research facilities, and/or faculty mentors?

3. Credit Awards
   a. If the receiving institution is conferring a degree, how will academic credit earned at the transferring institution apply? Will the collaborating institutions develop a pre-defined system that gives credit automatically when certain requirements are met? Or will credit be awarded on a case-by-case basis? Can the collaborating institutions develop a hybrid approach that includes some automatic credit awards and some case-by-case determinations?
   b. If the receiving institution will host visiting students without conferring a degree, will the students' home institutions accept credit? How will that credit appear on students' transcripts?

4. Participating Academic Disciplines
   a. Do the institutions want to establish a strong collaborative structure from the outset, or do they prefer to pilot the collaborative relationship with a small program?
   b. What is the nature of faculty interest in collaboration? Is it strong enough to allow the collaborative agreement to apply institution-wide, or is support concentrated in specific departments? If a collaborative agreement "starts small," should it also include built-in mechanisms to expand to additional departments if faculty interests spreads as a result of initial successes?
   c. Should the collaborative agreement allow different departments to adopt different guidelines for admissions and credit awards?
   d. Are there opportunities for faculty to build relationships and explore mutual areas of interest to foster broader reach of educational collaboration?

5. Agreement Management
   a. If a problem arises, how will the institutions respond to it?

© American Association for the Advancement of Science, 2012

b. How will student conduct issues be addressed?
c. Who is responsible for each part of the collaborative relationship?
    i. What roles will institutional leadership play?
    ii. How will faculty members' interest be gauged and stoked? Are there faculty champions willing to take a leadership role and to involve other faculty members, both junior and senior? What level of faculty support is needed for the collaboration to be successful?
    iii. How will advising and support staff be included in the collaborative process?
    iv. Will students have an opportunity to give input?

6. Program Monitoring
    a. How frequently and through what means will the institutions assess the success of their collaboration? How often will the institutions revisit their collaborative agreement's terms and policies?
    b. Who will collect and analyze agreement-related data?

7. Supplementary Strategies and Policies
    a. How will collaboration-based opportunities be marketed to students?
    b. How will the institutions develop student-transition-friendly financial aid policies?
    c. How will joint advising and mentoring programs be structured?
    d. Will prior learning assessments, online courses, or other flexible credit-granting program be involved? If so, how do the institutions' standards align?

B. **Thinking Through the Process: Preparing for, Initiating, and Forming the Collaborative Agreement**

A collaborative agreement can offer all participating institutions an opportunity to improve and expand their STEM programs. To be successful, however, the agreement needs to be tailored toward specific goals and supported by key stakeholders.

This paper's broad, adaptable framework, reflected in Table 2, does not prescribe one pathway to attain institutional goals, but instead gives detailed but generalized guidance to illustrate key elements intrinsic in successful collaborative agreements.[37] As a complement to this section, Appendix C presents a sample full-text template of an institutional collaborative agreement. Though primarily intended to aid institutional counsel in drafting language for an agreement, other institutional leaders may find it helpful.

[37] The steps in Table 2 should not be regarded as strictly linear, though they do progress from one stage to another. In addition, institutions may be able to skip some steps, complete multiple steps at once, or change the order of steps according to institutional experience and needs. Moreover, an institution with more experience in collaboration may not need to spend as much time on its internal evaluation. And course equivalency – often the most arduous step in the agreement process – may not need to be determined until after a pilot program has identified a few specific "problem courses."

© American Association for the Advancement of Science, 2012

Table 2: Key Objectives and Steps Toward Effective Collaboration		
Phase	**Objective**	**Action Steps**
1: Internal evaluation and preparation	A. Project Purpose	1. Target specific student populations as beneficiaries of collaborative agreement 2. Identify gaps in STEM academic programs and opportunities to fill them 3. Identify gaps in diversity of students in particular disciplines
	B. Outreach	1. Gauge faculty interest in collaborating with colleagues at possible participating institutions 2. Assess attitudes of faculty and academic leadership about collaborative programs for baccalaureate or advanced degree candidates from possible participating institutions 3. Identify which departments and/or colleges will participate in the program 4. Recruit a faculty champion for each participating department and college 5. Include transfer admissions officers and student advisors in the discussion for undergraduate recruitment. For graduate and doctoral programs, include faculty members who are actively involved in recruitment 6. Evaluate institutions as potential collaborators
	C. Preliminary program design	1. Instruct participating departments to determine course requirements for transferring or graduating students, a prerequisite for the course equivalency evaluation 2. Decide whether or not to set preferences on transfer or graduate admission and/or credits honored, and establish parameters for policies and processes accordingly to prepare for agreement negotiations
	D. Legal and policy considerations	1. Locate any federal and state statutes and policies that outline parameters for transfer credits or degrees[38] 2. Determine whether formal changes in existing admissions or transfer policies are required 3. Review internal requirements for collaborative agreements 4. Ensure that the legal requirements of one institution align with those of the other (especially important for agreements between institutions in different states or where multiple institutions will deliver a portion of a degree program under federal law)
2: Building Potential Collaborative Relationships	A. Groundwork	1. Assess and open communication lines between institutions 2. Perform course equivalency evaluation (if necessary)
	B. Negotiations	1. Decide on the vehicle for agreement 2. Decide how credits will be awarded 3. Determine whether transfer admission will be guaranteed, preferenced, or based on individual student performance
	C. Post-agreement programs	1. Establish joint or complementary student counseling services 2. Explore programming to support student transitions[39]

---

[38] *See* W. Interstate Comm'n for Higher Educ. & Hezel Assocs., Promising Practices in Statewide Articulation and Transfer Systems 5-9 (2010), http://www.hezelassociates.com/component/docman/doc_download/20-promising-practices-in-statewide-articulation-and-transfer-systems.

[39] A full discussion of complementary programs can be found in Section III, below.

© American Association for the Advancement of Science, 2012

Phase One: Internal Evaluation and Preparation

Once an institution decides to explore collaborative agreements as a way to improve STEM programming, it should perform a thorough internal review, including outreach to faculty and departmental leadership. Identifying and encouraging faculty champions who have the pedagogical and intellectual interest is a fundamental requirement of the early stages of the process. As faculty members lead design of the academic program, the institution's administrative and legal support team has a substantial role in designing the administrative and legal vehicle to deliver that academic program.

Objective A: Project Purpose

Clarity of purpose is a prerequisite for any collaborative relationship or agreement. To reach this objective, each institution should identify its own needs, goals, and preferences for the potential collaborative arrangement. Specifically, the institution may assess gaps and strengths in STEM academic programs, the diversity of students in STEM disciplines, and the goals of the institution’s STEM academic and research endeavors. This assessment will help show how the institution could best benefit from and contribute to potential collaborators—and help identify the qualities the institution most desires of a collaborating institution. As discussed in the Background and Overview, part of this analysis concerns whether the entry points at the receiving institution will involve undergraduate programs, advanced degree programs, or both.

First, an institution will likely target specific student populations as beneficiaries of any potential agreement. Relevant questions associated with this objective may include:

- What access points to the institution do students already have? Are student transitions a part of the institution's culture?

- Do existing access points work in STEM fields? Will students who transition midway through their undergraduate degree programs have trouble meeting the receiving school's expectations or fitting into its academic culture? Are there different entry points that would be more effective and possible for STEM programs? Can support measures be developed to assist students during the transitional period?

- What are the institution's legally sustainable diversity objectives? Are those goals being met? If not, what steps are being taken to improve outreach, admissions, and retention efforts for diverse student populations?[40]

- What kinds of students does the institution serve? Do successful students share characteristics? What about unsuccessful students? Do these characteristics differ for successful and unsuccessful students in the institution's STEM disciplines?[41]

---

[40] These questions will require collaboration with legal counsel and jurisdiction-specific analysis.

[41] Answers to some of these questions may be found by performing a multi-variable regression analysis of the institution's student data. Such an analysis will help to isolate the factors that contribute to student success or

© American Association for the Advancement of Science, 2012

- Do students indicate STEM as academic areas of interest at the outset of postsecondary studies, but fail to complete degree programs? Can student advisors or students themselves help explain these students' choices?

The institution also should identify gaps in STEM academic programs to define how collaborative opportunities can fill them. Relevant questions may include:

- What STEM departments does an institution have? Are some departments particularly effective or ineffective? Are there plans to enhance the performance of ineffective departments?

- Do the institution's faculty members ascribe to distinct pedagogical methods and objectives? Have STEM instructional practices ever undergone any significant changes?

- Are any STEM course offerings oversubscribed or underutilized?

- Do students tend to perform well or poorly in particular courses or departments?

- Do students experience a diverse learning environment within STEM courses? Do students frequently interact with faculty members and students with different perspectives and experiences from their own?

Because a collaborative agreement involves many stakeholders, including first and foremost faculty members as well as institutional leadership, admissions staff, and academic advisors, it can only move forward if everyone is on the same page about *why* collaboration makes sense for the institution and its students.

"Because a collaborative agreement involves many stakeholders, including first and foremost faculty members as well as institutional leadership, admissions staff, and academic advisors, it can only move forward if everyone is on the same page about why collaboration makes sense for the institution and its students."

Objective B: Outreach

While evaluating the institution's needs and goals in STEM programs, institutional leadership should be sure to include key stakeholders within the institution in the process of developing the goals and structure for the prospective collaborative relationship. Gauging initial faculty support is particularly important. Professors must own the program if it is to be sustained, will evaluate academic programs and course equivalencies in the development stage of the collaboration,

---

failure so that institutions may identify students who would benefit most from enhanced mentoring or other support services as part of the collaborative agreement.

© American Association for the Advancement of Science, 2012

and will advise and encourage students once the agreement is in place. It is often helpful to have an inaugural faculty champion who is committed to increasing access and diversity, interested in multi-institutional collaboration, and willing to assume a leadership role within the faculty.[42] To decide what STEM departments to target in the search for faculty champions, institutional leadership will use the information gleaned from the initial assessment of its STEM academic programs, student populations, diversity objectives, and research and development goals. Once faculty support has been evaluated and faculty champions are recruited, institutions should identify which departments will participate in the collaborative agreement. Not all departments need to participate in the same way; some may choose not to participate at all. But the participating departments should understand and embrace the new ways students are being recruited and the means by which increased student retention and achievement in STEM fields will occur.

Throughout the outreach stage of the internal evaluation, transfer admissions officers and student advisors – the most likely to come into actual contact with potential transitioning students – should be included in the dialogue. These individuals can provide helpful guidance on student needs, existing relationships with other institutions, and other institutions that are viable candidates for collaboration.

A number of considerations come into play as an institution starts to determine which institutions would be potentially the most effective partners in collaboration. In some cases, institutions of the same type will want to develop pathways for their respective students to enter one another's graduate programs – a situation in which both institutions transfer and receive students. Other scenarios involve clearly defined transferring and receiving institutions as students start at one institution and, after completing initial academic requirements, transfer to the second institution.

Collaborations also can grow out of already-established relationships or arrangements between institutions. In some cases – particularly those involving transitions to master's or PhD programs – faculty members will have personal or professional connections with colleagues at other institutions on which to ground a relationship between institutions.

Geographic proximity can be especially effective in building institutional relationships. Not only does physical location give receiving schools access to a new pool of local talent, but it also allows the institutions to develop relationships more naturally. Some collaborative agreements, like the Fisk-Vanderbilt program, described later in this paper, use geographic proximity to facilitate cross-registration for courses, joint research endeavors, and shared counseling services and data. A nearby location can be a selling point for receiving schools to pitch to

[42] Correspondingly, institutions should be sure to create a team of policy and legal experts to support and work with the lead faculty champion.

© American Association for the Advancement of Science, 2012

talented students who may wish to stay close to their transferring institution.[43] This may be especially true for students who initially matriculate to a community college and may lack the ability or inclination to relocate. A shared location may be particularly effective for collaborative relationships between research institutions and minority-serving institutions, the vast majority of which are located in specific regions – historically black colleges and universities are mostly in the southeast while Hispanic-serving institutions and tribal colleges and universities are generally in the southwest.[44] But though geography may pose opportunities, physical distance is not necessarily a constraint in a society that is increasingly mobile and globally-oriented. Distance education, for example, can offer easy connections anywhere.

Objective C: Preliminary Program Design

Having identified the purpose, beneficiaries, and stakeholders of a potential collaborative agreement, institutional leadership should begin on preliminary program design. By examining options for collaborative structure and determining which of those options best meets institutional and student needs, institutional leadership will be prepared to explain those choices to its prospective partners. Developing preferences and parameters for credit awards, admissions, or other agreement elements will allow an institution to be able to approach and negotiate with possible partners more effectively and efficiently. Though they may not be the policies that eventually are agreed upon during negotiations, preferences and parameters will help the institution determine what it seeks from its fellow collaborating institution.

Institutions that are exploring collaborative arrangements should consider, in light of their goals for the collaboration and the character and policies of their institution, what they need from a collaborating institution. For example, are they seeking an arrangement for student transitions between institutions of the same academic level?[45] Student transitions from one institution that can enhance student preparation to another institution that offers higher level courses?[46] Or advanced-degree student transitions from undergraduate programs to graduate and/or PhD programs?

For collaborative arrangements involving undergraduate student transfers from community colleges or smaller four-year institutions to four-year institutions with more comprehensive services and resources, STEM departments of prospective receiving institutions should determine course requirements for transferring students. This step is a prerequisite for the

[43] An academic dean at Georgia Tech explained that he used geography to attract students who could transfer to virtually any school in the country but wanted to stay close to friends or family in Atlanta. Interview with Associate Dean, Coll. of Computing, Georgia Inst. of Tech. (June 29, 2011).

[44] For a list of minority serving institutions and all-women's colleges, see Appendix E.

[45] For example, does the collaboration involve institutions of similar academic quality but different sizes, such as a collaboration between a small historically black colleges and a large majority-serving research institution?

[46] The most common example of this type of collaboration fosters student transitions from a community college to a four-year institution.

© American Association for the Advancement of Science, 2012

course equivalency evaluation which may occur in Phase Two.[47] Departments can base these decisions on what general education and major prerequisites are already required. If a department demands a particular pedagogical approach or classroom environment, it should relay this information as soon as possible to head off problems later in the agreement process. Meanwhile, prospective transferring institutions can determine how their course offerings line up with typical baccalaureate degree requirements.

The receiving institution also needs to describe its transfer admission policies and methods of determining how to recognize credits earned at the transferring institution. The receiving institution must consider whether it is willing to adjust its generally applicable transfer admission policy or whether it will create special guidelines to facilitate the transitions of students from prospective collaborating institutions. These are threshold parameters for the pursuit of the collaboration.

Objective D: Legal and Policy Considerations

The process of initiating a new collaborative agreement must include a review of relevant federal and state law and policies as well as accreditation requirements. Typically, these policies affect more traditional forms of student transfer, such as community college to four year transitions, and do not hamper institutions in developing innovative collaborative arrangements. That said, many states have defined parameters for certain types of transfer agreements that may affect the way that an institution-led agreement can be structured.[48] Additionally, some institutions may need to adhere to other requirements for collaborative agreements, including internal policies or institutional membership in a particular organization that has its own standards for collaborative agreements.[49]

When vetting potential agreement participants, institutions should consider how the two institutions' legal and accreditation requirements could align. Those institutions preparing for an inter-state collaboration should pay special attention to how to align the institutions' differing requirements, if any.

---

[47] A course equivalency evaluation involves the determination of how courses at the transferring institution compare to courses at the receiving institution. A lengthy discussion on this step of the collaborative agreement process can be found in Appendix B: How to Conduct a Course Equivalency Evaluation.

[48] A sampling of state policies on two-year to four-year transfers is included below, note 71.

[49] Institutions in 11 states, for example, participate in the Southern Association of Colleges and Schools' Commission on Colleges, which has encouraged its members to promote student transfers and set standards for all collaborative arrangement agreements adopted by its members. COMM'N ON COLLEGES, S. ASS'N OF COLLEGES & SCHS., TRANSFER OF ACADEMIC CREDIT: POSITION STATEMENT (approved June 2003), http://www.sacscoc.org/pdf/081705/transfer%20credit.pdf; COMM'N ON COLLEGES, S. ASS'N OF COLLEGES & S, COLLABORATIVE ACADEMIC ARRANGEMENTS: POLICY & PROCEDURES (approved June 2010), http://www.sacscoc.org/pdf/Collaborative%20Arrangements%20final.pdf.

© American Association for the Advancement of Science, 2012

Phase Two: Building Potential Collaborative Relationships

Once internal evaluations are completed and legal and policy requirements are examined, institutions will be able to target potential agreement participants through appropriate institution-wide or departmental leadership, depending on the scope and nature of the arrangements as well as the participating institutions' policies and customs.

Objective A: Groundwork on Course Equivalencies and Credit Transfer

The course equivalency process that applies to student transitions at the undergraduate level is an often arduous and tedious process that determines how the two institutions' courses and curriculum align. Not all collaborative agreements will need to undergo course equivalency determinations at the outset and, for those agreements that do, not all course equivalency evaluations have to be performed during initial negotiations between institutions. For example, institutions may initiate a pilot program with a small number of students to identify which courses or course sequences cause the most problems during student transitions. After those problem courses have been identified, institutional leadership can instruct curriculum committees to address those narrow issues, rather than having to embark on a full course equivalency evaluation. Institutions exploring collaborative agreements for the first time may find this approach to course equivalency more expedient and less arduous.[50] If a pilot program is pursued, however, participating institutions should be careful to protect students who participate in the pilot. For example, if pilot program participants commonly lose credit earned at the transferring institution when they transition to the receiving institution, and the institutions amend credit awarding schemes, the pilot program participants should be able to regain those lost credits retroactively.

Determining course equivalency is difficult because it requires a detailed comparative review of curricula which must be approved by many levels of authority.[51] Individual faculty members and departments must determine which of their courses correspond to courses at the collaborating institution. Transferring schools must determine whether their general education (GE) and early STEM major requirements fit what the receiving schools demand of their own matriculants.[52] Meanwhile, receiving schools must evaluate whether the transferring school's courses align with their own GE and STEM major requirements and, if they do not align, how to assimilate transitioning students into the fold.

[50] When pursuing pilot agreements, it is often helpful to allow the term to end automatically at the conclusion of the pilot period unless the parties take affirmative steps to extend the arrangement. This permits an unsuccessful collaboration to end with a minimum of conflict and without forcing either party to take an explicitly negative step. Institutional leadership should take care, however, to keep track of expiration dates.

[51] *See, e.g.,* Stephen J. Handel, *Articulation: The Currency of Transfer?* 3 (Destinations of Choice Initiative: A Reexamination of America's Community Colleges, CollegeBoard, Working Paper No. 3, 2008) ("When educators from two- and four-year institutions gather to discuss transfer, the transferability of course work – of the lack of it – is the first thing that is blamed.").

[52] In this paper, a "matriculant" is a non-transfer student who began his or her academic career and earned his or her degree at the same four-year institution.

© American Association for the Advancement of Science, 2012

Additionally, institutions must decide how to deal with twice-transferred credit.[53] For example, will both schools accept the same scores on AP exams? Will a Professional Learning Assessment (PLA)[54] accepted at one school transfer to another? Although these questions need not be answered within the general agreement, institutions should keep them in mind when developing overall transfer credit standards and student advising policies. Students in pilot programs may be particularly vulnerable to losing credit at this stage.

For a detailed explanation of the course equivalency process, including overarching principles as well as situational and operational considerations, see Appendix B: How to Perform a Course Equivalency Evaluation. Though answers for individual institutions and agreements will vary, the principles given in Appendix B can help guide the process for the faculty members and department heads who determine equivalencies and can aid university leadership and counsel in evaluating course equivalency decisions made by departments and faculty members.

Objective B: Negotiations

When institutional relationships begin to gel and course equivalency has been determined, institutions then may determine the form of collaborative agreement – either a detailed agreement[55] or a simple memo of understanding – and negotiate key mechanisms of the agreement, which include criteria and policies for transfer admissions and the awarding of credit. Transfer admissions may be preferenced, guaranteed, or based on more traditional methods of assessing individual applicants. Credit awards may be made on a case-by-case basis under generally applicable criteria, or through some schematic, pre-defined pathway. Though many institutions base admissions and credit decisions on individual student achievement, several systems have established schemes which cut down on administrative costs and provide greater predictability for transitioning students.[56] A detailed discussion of these programs can be found in Section III.

Objective C: Post-agreement programs

Even perfectly-constructed agreements do not guarantee the success of a collaborative arrangement. Student-focused policies and programs that complement and reinforce agreements often make the difference for student success. Along with specific contractual language on academic requirements, institutions should discuss how to offer joint counseling services and align extra-curricular programming, financial aid, and student counseling services that include mentoring and community building programs. A lengthy discussion of these opportunities can be found in Section IV.

---

[53] "Twice-transferred credit" refers to credit which a student was awarded at one institution, transferred to a second institution, and now attempts to transfer to a third institution.

[54] PLAs will be discussed more fully below in Section IV.

[55] A template of an institutional collaborative agreement can be found in Appendix C.

[56] Table 3, below, discusses credit-awarding options that include block credit transfer, general education common core, major articulation systems, and transfer associate's degrees.

© American Association for the Advancement of Science, 2012

Section III. *Structuring Operations and Responding to Users:* Models for Implementing the Framework

Once institutions have addressed key issues in ways that will drive the development and implementation of collaborative agreements, they can turn to the specifics. Though each collaborative agreement will be different, most agreements fit into a few structural models based on types of institutions and students. This section outlines three principal types of collaborative agreements:

A. Collaborations between Community Colleges and Four-Year Institutions
B. Collaborations between Four-Year Institutions
C. Collaborations Creating Pathways into Graduate and Doctoral Programs

Although each type of agreement exhibits common elements, there are sufficiently important distinctions among them—principally related to the student populations of relevance and as the unique characteristics of each relevant institution— to justify categorization. Nothing precludes an institution from pursuing more than one type of collaborative agreement. In fact, some institutions, including Georgia Tech's College of Engineering (described below), have made a systemic commitment to collaboration by pursuing multiple types of agreements.

The Smart Grid: Forming Different Kinds of Relationships

Like energy distributors forming relationships with different types of energy generators, institutions often need to adapt collaborative agreements based on the type of institution and students involved. Just as agreements with renewable energy providers will look different from those with traditional power plants, so institutional agreements with community colleges will differ from those with other four-year institutions or with graduate programs.

It goes without saying that institutions considering collaborative relationships should not consider themselves tied to any one form of collaboration. The framework and organization provided is intended to be both broadly illustrative and informative with respect to key policy and legal issues. Indeed, institutions that have collaborative relationships with a variety of other institutions are often the most successful in helping transitioning students succeed.

© American Association for the Advancement of Science, 2012

<u>Focus on Institutional Commitment to Transitioning Students</u>

The Regents' Engineering Transfer Program at the Georgia Institute of Technology
Transferring institutions: Public two-year and four-year
Receiving institution: Public research

Since 1969, the Georgia Institute of Technology's (Georgia Tech) College of Engineering has fostered relationships with other institutions to offer more Georgia students the opportunity to pursue STEM degrees. Georgia Tech's commitment to transfer degrees is clear: each year, it awards one third of its engineering degrees to graduates who were not matriculants. Interest in transfer agreements was initially generated because Georgia Tech was the only institution in Georgia that offered engineering degrees. Rather than expending resources on developing new programs in other state institutions, the Georgia Board of Regents initiated the Regents' Engineering Transfer Program (RETP), which gives transferring students clear pathways for guaranteed acceptance into Georgia Tech's College of Engineering. Today, Georgia Tech has relationships through RETP with 19 other Georgia institutions, including community colleges, historically black colleges and universities, and other state four-year institutions. Georgia Tech's experience shows that an elite university is not limited to a single form of transfer agreement. Instead, it can use many collaborative affiliations to attract talented students from a variety of transferring schools.

A. Collaborations between Community Colleges and Four-Year Institutions

Background

The United States is home to nearly 1,200 accredited community, junior, and technical colleges that have open admissions policies and can provide the first two years of a baccalaureate education.[57] Though community colleges traditionally have had a lower profile than their four-year counterparts, they are taking on a more visible and robust role today due to increased enrollment[58] and heightened national attention to how the community college mission can support the goals for America's workforce and higher education system as a whole.[59] For example, many of today's community colleges are evolving beyond their status as open-admissions junior colleges into institutions with more comprehensive services and programs, including some baccalaureate degree offerings in applied fields, nursing, and teacher

[57] George R. Boggs, Am. Ass'n of Cmty. Colls., *Democracy's Colleges: The Evolution of the Community College in America* 1, Presented at White House Summit on Community Colleges (Oct. 5, 2010). http://www2.ed.gov/PDFDocs/college-completion/01-democracys-colleges.pdf.

[58] Community colleges serve 44% of America's undergraduates, and enrollment between the fall of 2008 and fall of 2010 is estimated to have increased 15%. Am. Ass'n of Cmty. Colls., *2011 Fact Sheet* 1 (2011).

[59] For example, President Barack Obama's 2020 Goals for Education include a challenge to community colleges to produce an additional five million graduates. Press Office, White House, *Excerpts of the President's Remarks in Warren, Michigan and a fact sheet on the American Graduation Initiative* (July 14, 2009), http://www.whitehouse.gov/the_press_office/Excerpts-of-the-Presidents-remarks-in-Warren-Michigan-and-fact-sheet-on-the-American-Graduation-Initiative/.

© American Association for the Advancement of Science, 2012

education.[60] Collaborative agreements with four-year institutions have great potential to strengthen community colleges' contributions to the workforce and economy by creating more options for students to prepare more thoroughly, study, and succeed.

> ***Spotlight On: Community Colleges and STEM***
>
> Over 40% of STEM degree holders attended a community college in some capacity during their academic careers.[61]

Community colleges serve 44% of America's postsecondary students.[62] Students choose to attend community college for a variety of reasons. Some want a cost-effective alternative while they complete general education requirements and major prerequisites.[63] Others may need remedial course work due to inadequacies in their K-12 education (not necessarily the students' own capabilities). Some may prefer more intimate classroom environments. Many want or need to stay close to home. Most work while in school to support themselves and, in many cases, their dependents. Motivated by one or more of these considerations, many students – especially those who are minority, low-income, and/or non-traditional[64] – are more likely to begin their college careers at community colleges.

Most community college students want to transfer to a four-year school and earn a baccalaureate degree.[65] But, within six years, only about half of those students succeed.[66] One major barrier for community college student transfer to four-year institutions is that those students who do transition successfully often lose credits or must repeat classes at the receiving school. One study found that such students graduate with an average of 140 credits –

---

[60] Boggs, note 57, above, at 1.

[61] JOHN TSAPOGAS, INFOBRIEF: THE ROLE OF COMMUNITY COLLEGES IN THE EDUCATION OF RECENT SCIENCE AND ENGINEERING GRADUATES, NSF 04-315 , at 1, t.1 (2004).

[62] *Id.*

[63] While 73.2% of undergraduates at four-year institutions had a tuition and fees budget of $11,000 or *more,* 78.2% of undergraduates at community colleges had a budget of $11,000 or *less.* U.S. Dep't of Educ., Nat'l Ctr. for Educ. Statistics, 2007-08 National Postsecondary Student Aid Survey: Undergraduate Students.

[64] The Department of Education characterizes non-traditional students as those who show any of the following characteristics: delayed enrollment (any time after the first semester after high school graduation); part-time attendance for at least part of the academic year; full-time employment; financial independence from parents or guardians; single parenthood; has dependents other than a spouse; GED instead of high school diploma. U.S. DEP'T OF EDUC., NAT'L CTR. FOR EDUC. STATISTICS, NONTRADITIONAL UNDERGRADUATES 2-3 (2002).

[65] Surveys show that at least 50% and as many as 80% of community college students intend or desire to transfer. Stephen J. Handel, *Improving Student Transfer from Community Colleges to Four-Year Institutions – The Perspective of Leaders from Baccalaureate-Granting Institutions*, The College Board, at 6 (2011) (citing National Center for Education Statistics, IPEDS Fall Enrollment Survey(2008)), http://advocacy.collegeboard.org/sites/default/files/11b3193transpartweb110712.pdf.

[66] U.S. Dep't of Educ., Nat'l Ctr. for Educ. Statistics, *Community College Students: Goals, Academic Preparation, and Outcomes*, Postsecondary Education Descriptive Analysis Report NCES 03-164, at vi (2003), http://nces.ed.gov/pubs2003/2003164.pdf.

© American Association for the Advancement of Science, 2012

20 more than what generally is needed for a baccalaureate degree.[67] Many community college students – especially those who have significant personal or financial concerns – find the process of transfer to a four-year institution difficult to accomplish alone. Lost academic credits, inadequate financial aid, and a lack of support structure too often erect barriers between a student's academic goals and his or her ability to achieve them.

These circumstances have led to a popular – but mistaken – belief that that students who start at community colleges will be unable to succeed at four-year institutions. In fact, transitioning students from community colleges earn similar numbers of non-remedial credits and earn baccalaureate degrees at the same rate as their non-transfer counterparts at four-year institutions.[68] The key question for institutional leadership to answer is this: How can we make the transition between community college and a four-year institution more accessible for students? By working together to define academic pathways, set course transfer standards, and provide for seamless transition, community colleges and their four-year collaborating partners can help more students succeed.

"The key question for institutional leadership to answer is this: How can we make the transition between community college and a four-year institution more accessible for students? By working together to define academic pathways, set course transfer standards, and provide for seamless transition, community colleges and their four-year collaborating partners can help more students succeed."

---

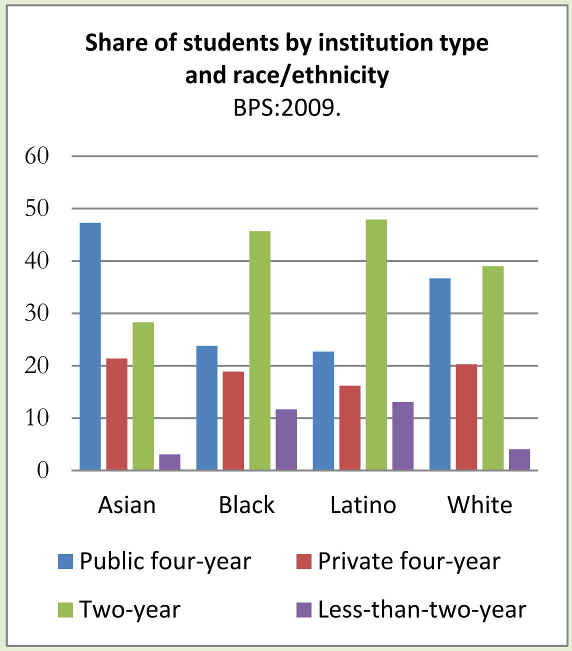
[67] CENTER FOR AMERICAN PROGRESS, ARTICULATION AGREEMENTS AND PRIOR LEARNING ASSESSMENTS: TOOLS TO HELP 21ST CENTURY STUDENTS ACHIEVE THEIR POSTSECONDARY EDUCATION GOALS AND KEEP AMERICA COMPETITIVE 2 (2011), http://www.americanprogress.org/issues/2011/06/pdf/college_credits.pdf.

[68] This similarity is shown when controlling for other demographic, educational, or economic variables. Tatiana Melguizo, Gregory S. Kienzl, & Mariana Alfonso, *Comparing the Educational Attainment of Community College Transfer Students and Four-Year College Rising Juniors Using Propensity Score Matching Methods*, 82 J. HIGHER EDUC.265, 280 (2011).

© American Association for the Advancement of Science, 2012

Wondering where the diversity in America's institutions of higher education exists? Community colleges can tell you.

- Community colleges are home to 44% of African-American and 55% of Native American students in higher education.[69]
- Latinos are more likely than other racial or ethnic group to begin postsecondary education at a community college;[70] nearly 60% of Latinos in higher education are so enrolled.[71] For example, at Arizona State University, a major four-year institution with a large Latino population, 67% of all students and 73% of the Latino bachelor's degree recipients in 2002–03 attended one or more local community colleges before obtaining their degree.[72]
- Forty-two percent of first-generation college students start at community colleges.[73]



The Mechanics of Collaboration

Collaborative agreements involving community colleges are affected more frequently by state law and policy than any other type of institution-to-institution arrangement.[74] This paper identifies and presents several strategies adopted by state systems not only to survey the regulatory landscape but also to provide inspiration on how to structure institution-led

[69] Am. Ass'n of Cmty. Colls., *2011 Fact Sheet* 1 (2011).

[70] CLIFFORD ADELMAN, U.S. DEP'T OF EDUC., MOVING INTO TOWN – AND MOVING ON: THE COMMUNITY COLLEGE IN THE LIVES OF TRADITIONAL-AGE STUDENTS 29, 32, t.10 (2005).

[71] U.S. Dep't of Educ., Nat'l Ctr. for Educ. Statistics, *Digest of education statistics, 2006* (2007).

[72] Alfredo G. de los Santos, Jr., & Gerardo E. de los Santos, *Latino/as and community colleges: A pathway to graduate studies?, in* THE LATINA/O PATHWAY TO THE PH.D 37, 48 (Jeanette Castellanos, Alberta M. Gloria, & Mark Kamimura, eds., 2005).

[73] Am. Ass'n of Cmty. Colls., *2011 Fact Sheet* 1 (2011).

[74] Because agreements between community colleges and four-year institutions in the absence of a state legal or policy framework are relatively rare, prospective partners in an institution-led agreement may need to prepare especially thoroughly to show that community college students can succeed in baccalaureate degree programs. A community college can show student success rates as well as the rigor, grading scales, and methodology of its courses. Its potential four-year collaborating partner can rely on transfer-friendly faculty and include plans for transitioning students in its overall enrollment strategy to lay the groundwork for the collaborative relationship.

© American Association for the Advancement of Science, 2012

voluntary collaborations.[75] Depending on the receiving institution's policies, these strategies may be applied to students admitted under the receiving institution's generally applicable admission criteria, although institutions may preserve the usual discretion to make admissions decisions on an individual basis and grant credit only to those students who are admitted.

Not intended to be mutually exclusive, these system components – including block credit transfer, general education common core, academic major articulation system, transfer associate's degrees, and common course numbering system – can be adopted as a suite or on an individual basis. Each practice can provide greater predictability for transitioning students, reduce administrative costs, and increase graduation and retention rates for participating institutions. Table 3 summarizes these practices.

---

[75] Some states have enacted statewide articulation policies affecting transition. The examples given here do not represent an exhaustive list but were selected to illustrate various structures for statewide programs that facilitate two-year to four-year transitions. A comprehensive review of state articulation policies can be found in W. INTERSTATE COMM'N FOR HIGHER EDUC. & HEZEL ASSOCS., PROMISING PRACTICES IN STATEWIDE ARTICULATION AND TRANSFER SYSTEMS 5-9 (2010), http://www.hezelassociates.com/component/docman/doc_download/20-promising-practices-in-statewide-articulation-and-transfer-systems.

- **VIRGINIA** has a guaranteed admissions policy for students who earn an associate's degree from one of 23 state community colleges and meet minimum GPA requirements. More than 20 of Virginia's four-year institutions have joined the program, with each setting its own admission requirements, including minimum GPA and maximum number of transferrable credits. The University of Virginia's College of Engineering requires a 3.4 minimum GPA, while the less-competitive Radford University requires a 2.8 minimum. Virginia's Community Colleges, *Guaranteed Transfer*, http://myfuture.vccs.edu/Students/Transfer/tabid/106/Default.aspx (last visited Aug. 16, 2011).
- With a legislatively-mandated transfer policy, **FLORIDA** uses a 2+2 articulation system in which all students who earn an associate's degree at one of Florida's institutions receive guaranteed junior status and admission at one of Florida's state universities. Students are not guaranteed admission, however, to a specific Florida university. FLA. STAT. 1007.23 (2011). Recently, Florida has allowed all state community colleges to transition to become "state colleges" and offer four-year degree programs. Part of the motivation this policy was to increase graduation rates for students who were unable or unwilling to transfer. Interview with Deputy Counsel, Fl. A & M Univ. (July 12, 2011).
- **ALABAMA** has a legislative mandate for a statewide articulation system which requires that all applicable credits transferred from a two-year institution fulfill degree requirements at the receiving school. ALA. CODE § 16-5-8 (2000).
- **ARIZONA** uses the Transfer General Education Core Curriculum, created in 1991, to facilitate statewide seamless transfer. The system created three major-based pathways for earning 41 block transfer credits; one path is geared toward STEM majors. AZ Transfer, AGEC Requirements: Overview (2010), http://www.aztransfer.com/AGECReqs.
- **OTHER MODELS: NEW JERSEY** and **NORTH CAROLINA** both have legislation which requires that a state associate's degree satisfies all general education requirements for other state colleges and universities, but does not guarantee admission. In **WASHINGTON,** applicants to state four-year institutions who hold state associate's degrees receive priority admission. COLLEEN MOORE, NANCY SHULOCK, & CRISTY JENSEN, INST. FOR HIGHER EDUC. LEADERSHIP & POLICY, CRAFTING A STUDENT-CENTERED TRANSFER PROCESS IN CALIFORNIA: LESSONS FROM OTHER STATES 12-14, t.5 (2009).

© American Association for the Advancement of Science, 2012

Table 3:
System Components to Smooth Transition between Community Colleges and Four-Year Institutions[76]

Requirement Name	Description	Incentive
Block credit transfer	Grouping of general education courses which transfers seamlessly to the receiving institution	♦ Cuts down on administrative work ♦ Gives students greater predictability in academic programs
General education common core	Set of first- and second-year courses that fulfills basic requirements and is transferable system-wide (or among contracting institutions)	♦ Gives students more predictability ♦ Can be structured to give institutions freedom in choosing which specific courses meet the common core requirements
Academic major articulation system	System which designates academic major requirements for all participating institutions	♦ Can target high-need majors, including STEM disciplines, to encourage more students to start and complete those degrees
Transfer associate's degree	Dual degree program which provides that students who earn associate's degrees can transfer to four-year institutions with junior status and (sometimes) guaranteed or preferenced admission status	♦ Provides valuable academic credentials and clear pathway for transfer for students ♦ Improves institutional retention and graduation rates
Common course numbering system	Designation system that ensures that the number of credits earned for a course at the transferring institution matches the number of credits awarded for that course by the receiving institution	♦ Can be particularly important for upper level (numbered in the 300-level) courses at community colleges which are often designated as 200-level courses at four-year institutions

Each of these components can be adapted to collaborating institutions' unique admissions and credit-awarding policies, parameters, and traditions. ***As institutional leaders review these options, they should keep in mind that they may preserve discretion in admissions and apply these credit-awarding strategies only to those students who are admitted.***

By providing more predictability and transparency for students, these mechanisms can help ease transitions from a two-year to a four-year institution.

Block credit transfer involves a grouping of courses – usually involving general education requirements for the first two years of postsecondary education – which transfer seamlessly to the receiving institution. The block of courses may involve some or all of the coursework

[76] Adapted from W. INTERSTATE COMM'N FOR HIGHER EDUC. & HEZEL ASSOCS., PROMISING PRACTICES IN STATEWIDE ARTICULATION AND TRANSFER SYSTEMS 5-9 (2010).

© American Association for the Advancement of Science, 2012

generally undertaken during the first two years of undergraduate study. To set up a block credit transfer, institutions need to perform a course equivalency evaluation of both institutions' basic requirements for freshman and sophomore year. Though this will entail a significant amount of work on the front end, the block credit transfer will cut down on administrative labor once the system is in place because admissions officers will be able to evaluate a student's transfer credits as a block, rather than one-by-one. Confident that they will receive credit for all courses in the block, students will be more likely to transfer successfully and complete their baccalaureate degree.

The general education (GE) common core also designates equivalent first- and second-year courses but offers more flexibility to students and receiving institutions in deciding which courses qualify for transfer. Rather than dictating a particular grouping of courses, the GE common core identifies a range of first- and second-year courses offered at each institution that are equivalent. Though the courses do not transfer as a single unit, they will transfer individually according to whatever parameters are set by participating institutions. Institutions can adapt this system to the unique needs or preferences of individual departments; for example, one department could require a B in an introductory course while another would take a C. Students benefit from knowing how courses between the two institutions align, the transferring institution can offer a wider array of qualifying classes, and the receiving institution is not required to accept credit in a whole cloth manner.

An **academic major articulation system** can be effective for targeting specific academic departments and programs for student transfers. It designates a set of GE requirements and major prerequisites at the transferring institution which are equivalent to those at the receiving institution. For STEM-specific collaborative agreements, such a system can be effective at encouraging students to start pursuing a STEM major early and helping them decide which courses they need to take to qualify for transfer.

A **transfer associate's degree** provides a student with an associate's degree from his or her transferring institution and the option of junior status at the receiving school. Again, the receiving school may retain its usual admission criteria and discretion. Once admitted, however, the transferring student's credits would be accepted, and his or her status would be that of a junior. Some programs also allow for preferenced or guaranteed admission at receiving institutions for students who earn an associate's degree at the transferring institution. In addition to providing students with valuable credentials and clear academic pathways, transfer associate's degrees allow the transferring school to increase its retention and graduation rates.

A **common course numbering system** eliminates the guesswork behind transfer credit by giving equivalent courses similar course numbering designations at each institution. This system ensures that courses taken at the transferring institution receive the same level of credit at the receiving institution. For example, some 300-level courses at two-year schools have been

© American Association for the Advancement of Science, 2012

designated as 100- or 200-level courses at four-year counterparts.[77] This discourages students from taking advanced courses at their two-year institution and, even if they do take higher-level courses, students may be deprived of full credit for them at transfer. Having a common course numbering system in place will prevent this problem from happening.

Other innovative system components are being developed for use by appropriate institutions. For example, the University of Texas – El Paso (UTEP) and El Paso Community College (EPCC) have developed a fully automated **reverse transfer system** which identifies potential EPCC associate's degree candidates currently enrolled in UTEP's baccalaureate programs and allows them to complete final requirements at UTEP. [78] With a single data scan from the UTEP information system, UTEP administrators can identify UTEP students who previously earned at least 15 credit hours at EPCC.[79] Based on previously determined course equivalencies, the computer also determines whether students who transitioned from EPCC have taken enough qualifying courses at UTEP to meet the requirements for one of four EPCC associate's degree programs.[80] Administrators hope that students will get a confidence boost from the additional credentials and be more likely to complete their baccalaureate degrees. Indeed, UTEP and EPCC benefit from higher retention and graduation rates. The reverse transfer program is one of many transfer-retention initiatives UTEP has put into place.[81] Between 2009 and 2010, retention increased 9%.[82] And because the reverse transfer program is essentially a bookkeeping program that made no curricular changes, UTEP did not need state approval to move forward. Other institutions, including the University of Massachusetts at Boston, are using the UTEP-EPCC model for their own programs.

---

[77] Undergraduate institutions usually number courses according to the year in which most students take them. Freshmen year courses are in the 100's, sophomore year courses in the 200's, and so on.

[78] Donna Ekal & Paula M. Krebs, *Reverse-Transfer Programs Reward Students and Colleges Alike*, CHRON. HIGHER EDUC. (June 19, 2011), http://chronicle.com/article/Reverse-Transfer-Programs/127942/.

[79] Telephone interview with Associate Provost, Office for Undergraduate Studies, Univ. of Tex. at El Paso (Aug. 4, 2011).

[80] The fact that the course equivalencies already had been determined played a major role in allowing UTEP to establish the program quickly. *Id.*

[81] External collaborations between UTEP and EPCC date back to 1991, with the creation of the Collaborative for Academic Excellence. The two schools are the only institutions of higher education in El Paso and its surrounding area. Many students take classes at both institutions during the pursuit of their undergraduate degrees. The Collaborative includes both institutions, 12 local school districts, the city's chamber of commerce, and representatives from local government and community organizations and seeks to develop better education pathways for students. Since the creation of the Collaborative, the relationship between EPCC and UTEP has deepened and strengthened. The two schools — which are both Hispanic-Serving Institutions – now collaborate on a wide range of programs, tools, and supports to boost student success and accelerate degree completion. Lumina Found., *El Paso colleges link up to lift students*, FOCUS, Spring 2011, at 13.

[82] Ekal & Krebs, note 78, above.

© American Association for the Advancement of Science, 2012

<u>Focus on Training Transfer-Ready Community College Students</u>

The Honors College at Miami Dade College
Transferring Institution: Public community college
Receiving institutions: Public and private four-year

Miami Dade College (MDC) enrolls six times as many Latino students as the entire Ivy League.[83] Now the largest institution of higher education in the United States with 174,000 students across eight campuses, MDC opened in the 1960s as a community college that served local populations of African-Americans and Cuban immigrants.[84] Since the 1980s, it has pursued aggressively academic reform and created over 50 new degree programs. In 2001, it created the Honors College, which admits high-achieving high school students for two years of intensive study at MDC followed by expected transfer to four-year institutions.[85] Honors College graduates have transferred to some of the most prestigious four-year institutions in the country, including Georgetown University, the Massachusetts Institute of Technology, New York University, the University of California – Berkeley, and Yale University.[86] In addition to the state-mandated transfer and articulation policies relevant to its practices, MDC has created student transition agreements with more than 60 public and private universities.[87] It maintains a comprehensive website which organizes articulation policies by school, state, and major and tags each receiving school's entry with potential scholarship opportunities.[88] By providing local students with rigorous academic programs in a cost-effective setting, MDC presents a new model for undergraduate success.

---

[83] Robert Margolis, *Community College Confidential,* EDUC. SECTOR (April 3, 2006), http://www.educationsector.org/print/publications/community-college-confidential. Ivy League institutions are increasing efforts to recruit Hispanic students, but since these institutions are home to a small fraction of American college students, these recruitment efforts have not produced systemic results.

[84] Miami Dade Coll., *About Miami Dade College*, http://www.mdc.edu/main/about/ (last visited Aug. 16, 2011).

[85] The Honors Coll., Miami Dade Coll., *About the Honors College*, http://www.mdc.edu/honorscollege/about.asp (last visited Aug. 16, 2011).

[86] The Honors College, Miami Dade College, *Graduation and Transfers*, http://www.mdc.edu/honorscollege/graduation.asp (last visited Aug. 16, 2011).

[87] MDC has agreements with all of Florida's public four-year institutions, 27 Independent Colleges and Universities of Florida (ICUF), and a host of out-of-state institutions including Drexel University, Georgia Tech, Michigan State University, Mount Holyoke College, Smith College, the University of Texas, and the University of Wisconsin. Miami Dade College, *Transfer Options*, http://www.mdc.edu/main/academics/transfer_options.asp (last visited Aug. 16, 2011).

[88] Academic and Student Affairs, Miami Dade College, *Articulation*, http://www.mdc.edu/asa/articulation.asp (last visited Aug. 16, 2011).

© American Association for the Advancement of Science, 2012

B. Collaborations between Four-Year Institutions

Background

As with collaborative arrangements involving community colleges, agreements between four-year institutions allow the transferring school to offer more options to its students and give the receiving school access to a diverse group of prospective students. Many students may be drawn to the mission, history, or culture of a particular school even though its curricular offerings may be limited. When deciding which college to attend, these students may determine that those factors outweigh their desire to pursue an interest or talent in STEM. Collaborative arrangements between four-year institutions can empower these students to access a broader range STEM academic programs and career paths.

Unlike agreements with two-year institutions, collaborations between four-year institutions are largely unregulated by state laws and policies, thus allowing institutions the freedom to create agreements as they see fit.[89] Smaller four-year institutions engage with larger institutions in order to offer students broader opportunities for research or specialized coursework. Such agreements can be especially attractive in STEM disciplines because they allow smaller institutions to expand academic program options for their students without having to make large investments in expensive laboratories and research facilities. Prospective receiving institutions may find that collaborative agreements give them access to larger populations of talented students who could make significant contributions in the classroom and the laboratory. Four-year institutions also may assist one another in retaining students in undergraduate STEM programs and recruiting graduate students by providing each other's students with summer research opportunities, providing their faculty with opportunities to meet potential graduate student recruits from the other institution, and building relationships between each others' students while they are undergraduates.

Two types of transferring four-year schools show particular promise for increasing diversity within STEM academic programs:

- ♦ Minority-serving institutions (MSIs), including historically black colleges and universities (HBCUs),[90] Hispanic-serving institutions(HSIs),[91] and Tribal Colleges and Universities (TCUs);[92] and

---

[89] Public institutions and their potential agreement counterparts should pay careful attention to any statewide articulation requirements, such as those discussed in Section III.A and noted in Table 3, above.

[90] Identified by the White House, HBCUs are those institutions that focus principally on educating black students, have been operating since at least 1964, and are properly accredited. White House Initiative on Historically Black Colls. &Univs., U.S. Dep't of Educ., *HBCU Home*, http://www2.ed.gov/about/inits/list/whhbcu/edlite-index.html (last updated July 8, 2010).

[91] HSIs are defined by federal statute as those institutions with at least a 25% Hispanic undergraduate full-time equivalent enrollment, and at which at least 50% of Hispanic students are low-income individuals. 20 U.S.C.A. § 1101a (2009).

© American Association for the Advancement of Science, 2012

- ♦ Liberal arts colleges, most of which enroll more women than men. Women's colleges are an important subset of the liberal arts college community.

> ***Spotlight on:***
> ***HBCUs and STEM***
>
> The 33 HBCUs with degree-conferring physics departments award about half of all baccalaureate degrees in physics earned by African-American undergraduates.[93]

Both historically and currently, HBCUs, HSIs, and TCUs provide an important access point for large numbers of minority students into higher education.[94] Historically, HBCUs offered higher education to black students when most colleges and universities were closed to them. HBCUs now award 15% of all undergraduate degrees nationwide to African-American students.[95] HSIs currently educate the fastest-growing demographic group in the United States, Latino students. Though HSIs only serve approximately 22% of students nationwide, they serve 61.6% of Hispanic students in higher education in the United States.[96] Forty percent of baccalaureate degrees earned by Hispanic students are at HSIs.[97] And TCUs ensure that students who live on tribal reservations or are of tribal descent have access to higher education. TCUs mostly grant associate's degrees,[98] and most students at TCUs are the first member of their families to

---

[92] TCUs are institutions chartered by one or more federally recognized American Indian tribes. They are located on reservations or in communities with a large American Indian population. 25 U.S.C.A. § 1801 (2008).

[93] Patrick Mulvey & Brandon Shindel, Am. Inst.of Physics Statistical Research Ctr., *Physics Bachelor's Demographic Profiles*, FOCUS ON, Aug. 2010, at 3, http://www.aip.org/statistics/trends/reports/bachdemograph10.pdf.

[94] When forming an agreement with MSIs, collaborating partners should be aware of the federal interest in and commitment to serving these colleges and universities. All MSIs are defined by federal statute or executive order. 20 U.S.C.A. § 1101a (2009) (defines HSI); 25 U.S.C.A. § 1801 (2008) (defines TCU); U.S. Dep't of Education, *White House Initiative on History Black Colleges and Universities*, http://www2.ed.gov/about/inits/list/whhbcu/edlite-index.html (last updated July 8, 2010) (defines HBCU and lists qualifying institutions).

[95] Remarks by Tony Miller, Deputy Sec'y, U.S. Dep't of Educ., College-Ready Students and Student-Ready Colleges, Sept. 14, 2010, https://www.ed.gov/news/speeches/college-ready-students-and-student-ready-colleges-remarks-deputy-secretary-tony-miller.

[96] Hispanic Ass'n of Colls. & Univs., *Facts on Hispanic Higher Education*, http://www.hacu.net/hacu/Data,_Statistics,_and_Research.asp?SnID=1234918590 (last visited Aug. 18, 2011); Nat'l Ctr. for Educ. Statistics, U.S. Dep't of Educ., *Fast Facts: Do you have information on postsecondary enrollment in rates?*, http://nces.ed.gov/fastfacts/display.asp?id=98 (last visited Aug. 18, 2011).

[97] ALICIA C. DOWD, LINDSEY E. MALCOM, & ELSA E. MACIAS, CTR. FOR URBAN EDUC., IMPROVING TRANSFER ACCESS TO STEM BACHELOR'S DEGREES AT HISPANIC-SERVING INSTITUTIONS THROUGH THE AMERICA COMPETES ACT 3 (2010).

[98] One study found that 68.3% of degrees granted by TCUs were associate's degrees. Symantic Research, Inc., Am. Indian Higher Educ. Consortium, American Indian Higher Education Consortium American Indian Measures for Success in Higher Education 2007 Fact Book 19 (2007). Because so many TCUs are community colleges, prospective collaborating institutions may wish to base collaborative agreements on the 2-year/4-year models presented in Section II(A), above.

© American Association for the Advancement of Science, 2012

attend college.[99] Receiving institutions may find that MSIs can provide the student diversity missing in their STEM programs.

MSIs are concentrated in particular geographic areas in the United States. About 90% of HBCUs are in the southeastern United States,[100] while HSIs are concentrated in the Southwest [101] and TCUs in the Midwest and Northwest.[102] Geography can be a powerful consideration for collaboration, but potential collaborating partners should consider the benefits of geographic diversity that these collaborations can offer.

Meanwhile, liberal arts colleges boast academic communities, intimate classroom environments, and student-centered learning. They attract a large share of female undergraduates, another group underrepresented in STEM. Because these institutions tend to be smaller, their STEM departments may be limited in scope and size and the number of major STEM research projects is likely to be modest. Collaborative relationships with other four-year institutions, particularly those that are research-based, can help liberal arts colleges expand their academic program offerings in STEM while retaining their intimate liberal arts mission and tradition.

The Mechanics of Collaboration

The most common type of arrangement between four-year institutions is the 3+2 or 3/2 agreement. Under this structure, students earn two baccalaureate degrees, one from their home institution and another from the receiving institution. Collaborating institutions can decide whether students will be admitted by each institution under its own admissions policies or whether students can apply under a joint admissions process. Students spend approximately three years of full-time study at their home institution and two years at the receiving institution. During the first three years of study, students complete general education requirements and take several prerequisite courses to prepare for transfer. The next two years are spent completing degree requirements at the receiving institution.

3+2 programs usually involve specific academic majors based on the resources of both institutions. Engineering 3+2 programs are the most common, although new models for other STEM disciplines are being developed as well. [103] For example, a student majors in physics at the transferring school and, after completing the first three years of study, enters an

---

[99] Am. Indian Higher Educ. Consortium, Who Goes to Tribal Colleges (Oct. 1998), http://www.aihec.org/colleges/documents/WhoGoestoTCU.pdf.

[100] White House Initiative on Historically Black Collss & Univs., U.S. Dep't of Educ., *List of HBCUs*, http://www2.ed.gov/about/inits/list/whhbcu/edlite-list.html (last updated Jan. 4, 2010).

[101] Hispanic Ass'n of Colls. & Univs., *HACU Member-HSIs Map* (Oct. 18, 2010), http://www.hacu.net/images/hacu/membership/pdf/hsi.pdf.

[102] White House Initiative on Tribal Colls. & Univs., U.S. Dep't of Educ., *Tribal Colleges & Universities List*, http://www2.ed.gov/about/inits/list/whtc/edlite-tclist.html (last updated Aug. 2, 2011).

[103] Some nursing and STEM teaching programs are available, but fall outside of the scope of this paper's discussion.

© American Association for the Advancement of Science, 2012

engineering major program at the receiving school. Generally, 3+2 agreements follow a well-defined academic pathway with many specific course requirements. As a result, less guesswork is involved in determining the transferability of individual students' coursework once the 3+2 pathway has been established.

Agreements will vary depending on institutional course requirements, general education course equivalency, and program structure. Considerations include:

- **Sequencing of degrees.** Institutions should decide whether the first degree will be awarded upon completion of credits at the transferring institution, one year into the program at the receiving institution, or after the completion of all coursework.

- **Timing of student residency.** Some programs also give students choices on when they study at each institution. Dartmouth allows its engineering transfer students to choose between two program structures: 2-1-1-1 or 3-2. In the former, students spend freshman and sophomore years at the transferring school, junior year at Dartmouth, senior year at the transferring school, and the fifth year at Dartmouth.[104] Similar to spending a year studying abroad, the 2-1-1-1 system allows students to pursue individual academic and career goals without giving up the emotional and personal significance of spending senior year at and graduating from their "home" school.

- **Participating STEM discipline.** Collaborative arrangements may need to be structured differently depending on the STEM discipline implicated by the agreement. Collaboration can get complicated if faculty members or departments see potential collaborators as competitors. Engineering has been the focus of most current agreements because most small institutions, including MSIs and liberal arts colleges, do not offer engineering degrees. Though all collaborative agreements share overarching principles, common departments like Biology, Computer Science, and Physics may structure their collaborative agreements differently, e.g. a baccalaureate to master's pathway.[105] Each institution must evaluate its needs carefully so that it can explain what gaps it hopes to fill with the new resources provided by the 3+2 agreement. Those leading the development of an agreement should take care to convey that the agreement is not intended to snatch students away, but rather to give students enhanced opportunities at a low cost to the institution.

- **Financial aid policies.** In addition to making academic plans, students need to know what to expect financially when they transition between institutions. This may be especially important for the 3+2 agreements that cross state lines. Additionally, because these programs take longer than the normal four-year period for baccalaureate-degree study,

---

[104] Thayer Sch. of Eng'g at Dartmouth, *Dual-Degree Program* (Dec. 10, 2010), http://engineering.dartmouth.edu/undergraduate/dual/.

[105] The Georgia Tech – Atlanta University Complex (AUC) planned program that enables computer science students to earn a baccalaureate degree at their AUC institution and a master's degree at Georgia Tech is discussed below.

© American Association for the Advancement of Science, 2012

they may cause students to reach the maximum number of credits for certain state scholarship programs before they finish the program.[106]

<u>Focus on Engineering 3+2 Collaborative Agreements</u>

3+2 Agreements at the University of Southern California
Transferring Institutions: Liberal arts colleges
Receiving Institution: Private research

The University of Southern California (USC) has established 3+2 programs between its Viterbi School of Engineering and several four-year liberal arts colleges, including the Claremont Colleges[107] and the University of San Francisco.[108] USC has tailored each 3+2 agreement for the particular transferring institution, but offers the following basic guidance on courses to take before transferring:[109]

- General Education -- Requirements vary by school.
- Mathematics -- Requirements vary by school and engineering major, but most students complete Calculus I, II, III, Linear Algebra, and/or Differential Equations.
- Physics -- Requirements vary by major. Sequence should cover thermodynamics, mechanics, electricity, magnetism, optics, and modern physics.
- Chemistry -- Requirements vary by major, but most students take General Chemistry I and II. Chemical and Biomedical Engineers will also be required to take Organic Chemistry prior to transfer.
- Computer Programming -- Computer Engineering and Industrial & Systems Majors should take C++, all other majors need MATLAB.
- Writing -- At least one semester of lower-division writing.
- Additional Engineering Coursework (if offered).

---

[106] In Georgia, for example, students only receive the Hope Scholarship – the state's guaranteed funding program for undergraduates who finished high school with strong GPAs and attend a state institution of higher education – for 120 credits of an undergraduate degree program. Students who require more credits to complete their degrees, even if their academic program demands it, "lose Hope" and are at greater risk of dropping out before graduation. Telephone interview with Eng'g Educ. Outreach Dir., Coll. of Eng'g, Ga. Inst. of Tech. (June 24, 2011).

[107] Scripps College, the women's college within the Claremont system, is one beneficiary of this arrangement. Scripps also has a number of 3+2 arrangements for students wanting to pursue engineering, including agreements with Harvey Mudd College, Washington University in St. Louis, Columbia University, Rensselear Polytechnic Institute, and Boston University. Scripps Coll., *About the Engineering Program*, http://www.scrippscollege.edu/academics/department/engineering/index.php (last visited July 27, 2011).

[108] Univ. of San Francisco General Catalog 2011-2012, *3/2 Engineering-Physics Dual Degree Program*, http://www.usfca.edu/catalog/artsci/phys/ddp/ (last visited July 27, 2011).

[109] Viterbi Sch.of Eng'g, Univ. of S. Cal. *3/2 Engineering Program*, http://viterbi.usc.edu/admission/transfer/threetwo.htm (last visited July 27, 2011).

© American Association for the Advancement of Science, 2012

The collaborative relationship between four-year institutions can take other forms besides 3+2 agreements. Institutions may also establish joint STEM departments or colleges that share facilities and faculty members and are open to students from all participating schools. In such situations, students usually will receive a degree from their home institution, but nevertheless benefit from the widened array of curricular and research opportunities possible because institutions share resources. For institutions, such an arrangement can be strategic both in terms of cutting costs and enhancing academic offerings and research opportunities.

Focus on Joint Colleges of Engineering

The Florida A&M University (FAMU) – Florida State University (FSU) College of Engineering
Collaborating institutions: Public research and Public HBCU

In Tallahassee, Florida, FAMU, a state HBCU, and FSU, a large research institution, share the FAMU-FSU College of Engineering, established in 1982.[110] During the 2009 fiscal year, the College supported 320 active research projects, 190 published papers, and annual expenditures of more than $26 million.[111] In 2010, FAMU was recognized as the top institution of origin in the nation for black students earning doctorate degrees in the natural sciences and engineering.[112] By sharing faculty, facilities, and student pools, the two four-year institutions are able to perform at a high level, reach a more diverse body of students, and provide the resources for student excellence.

[110] COLL. OF ENG'G, FLA. A&M UNIV.- FLA. STATE UNIV., RESEARCH REPORT 1 (2010).

[111] *Id.* at 51.

[112] Coll. of Eng'g, Fla. A&M Univ. – Fla. State Univ., *Prospective Students – Introduction*, http://www.eng.fsu.edu/prospective/ (last visited July 27, 2011).

© American Association for the Advancement of Science, 2012

C. Collaborations Creating Pathways into Graduate and Doctoral Programs

Background

STEM baccalaureate degree holders are more likely to enter into graduate programs than their non-STEM counterparts.[113] The proportion of these STEM graduates who enter research-based graduate and doctoral programs, however, remains low. One year after graduation, just 22.5% of STEM baccalaureate degree holders are enrolled in a master's or PhD program.[114]

Most master's and PhD STEM degree programs at American institutions fail to attract a diverse number of domestic students. While the number of minority U.S. citizens enrolled in these programs has more than doubled since 1989,[115] diversity among STEM graduate students remains low. Among U.S. citizens pursuing STEM graduate degrees in 2009, only 7.8% were African-American and 7.1% were Latino.[116] Women also are underrepresented in many STEM graduate and postgraduate programs. Some gains have been made: women made up only 27% of the advanced-level students in biological sciences in 1960 and, by 2000, represented about 44%.[117] Despite some gains, however, women remain significantly outnumbered in most STEM fields. In engineering and computer sciences, women make up less than a quarter of graduate and doctoral students.[118] African-American and Hispanic women have an especially tiny share of the STEM graduate and doctoral student population: less than 3% of doctorates in computer science, the physical sciences, engineering, and mathematics and statistics.[119]

---

[113] Over a period of 10 years after college graduation, 39% of STEM baccalaureate degree holders had some combination of STEM employment and graduate degree enrollment. Only 27.9% of non-STEM baccalaureate degree holders fit that category. NAT'L CTR. FOR EDUC. STATISTICS, U.S. DEP'T OF EDUC., TEN YEARS AFTER COLLEGE: COMPARING THE EMPLOYMENT EXPERIENCES OF 1992-93 BACHELOR'S DEGREE RECIPIENTS WITH ACADEMIC AND CAREER-ORIENTED MAJORS 20, t.4, NCES 2008-155 (2008).

[114] NAT'L CTR. FOR EDUC. STATISTICS, U.S. DEP'T OF EDUC., 2008-09 BACCALAUREATE AND BEYOND LONGITUDINAL STUDY (B&B 08/09), NCES 2011-238, at 13, t.5 (2011).

[115] PETER EINAUDI, NAT'L CTR. FOR SCI. &ENG'G STATISTICS, TWO DECADES OF INCREASING DIVERSITY MORE THAN DOUBLED THE NUMBER OF MINORITY GRADUATE STUDENTS IN SCIENCE AND ENGINEERING, INFO BRIEF 11-319, at 1 (2011).

[116] These proportions of African-American and Latino students in STEM graduate programs are about half of the share these groups have in the general population. Among populations of all U.S. citizens aged 21-45 in 2009, 13.8% were black and 11.9% were Latino. *Id.*

[117] CATHERINE HILL, CHRISTIANNE CORBETT, & ANDRESSE ST. ROSE, AM. ASS'N OF UNIV. WOMEN, WHY SO FEW? WOMEN IN SCIENCE, TECHNOLOGY, ENGINEERING, AND MATHEMATICS 14 (2010).

[118] In 2008, women earned 22% of computer sciences PhDs, 21.6% of engineering PhDs, 26.8% of computer sciences master's degrees, and 23% of engineering master's degrees. Though most of these numbers represent an increase since 1989 degree attainment levels by women in these fields, they also show the lingering disparity between male and female achievement in these fields. Nat'l Sci. Found., *Low participation fields for women: Computer sciences and engineering, 1989-2008* (*citing* NATIONAL SCIENCE FOUNDATION, WOMEN, MINORITIES, AND PERSONS WITH DISABILITIES IN SCIENCE AND ENGINEERING, NSF 11-309) (2011)), http://www.nsf.gov/statistics/wmpd/digest/theme2_1.cfm.

[119] Lindsey E. Malcom & Shirley M. Malcom, *The Double Bind: The Next Generation*, 81 HARV. EDUC. R. 162, 166 (2011).

© American Association for the Advancement of Science, 2012

Though American STEM graduate programs have greatly expanded enrollment, that growth is largely attributable to an influx of foreign students. Between 2000 and 2010, graduate enrollment in all science fields grew by 30% and in engineering programs – particularly civil, mechanical, and biomedical disciplines – increased 40%.[120] In 1966, U.S. citizens and permanent residents earned 84% of all doctoral degrees at U.S. institutions in STEM fields.[121] By 2004, that proportion had dipped to 60%, even though the number of STEM doctoral degrees awarded had more than doubled.[122] The fact that educating foreign students is critical to participating in and benefitting from our global society does not diminish the need to focus on American students being included in plans to expand STEM preparation programs. America cannot rely on foreign students remaining in the U.S. to satisfy the workforce and intellectual resource needs of U.S. industry. Nor can our nation rely on foreign citizens for national security jobs. When developing recruitment plans, universities should not neglect pools of domestic talent, particularly when certain groups remain underrepresented in STEM doctoral programs.

The Mechanics of Collaboration

Collaborative agreements for master's and PhD programs implicate a unique array of considerations that merit attention:

- **Focus on research.** Graduate and doctoral programs rely on students conducting research. Instead of the transferring/receiving institution dichotomy present in most undergraduate programs, institutions participating in collaborative agreements for advanced degree students usually share faculty, facilities, and course offerings for at least part of participating students' programs. Whether or not a collaboration agreement is in place, the relationships between students and faculty and referrals of students from one faculty member to another can be significant motivators in the selection of students for graduate programs. All collaborating institutions, therefore, must understand and take part in students' progress from one program to another, and the "hand off" of students to the institution that will grant the final degree must be structured carefully. The focus on developing students' research skills also provides institutions with a more holistic standard for admission than focusing only on GRE scores and GPAs. Summer research opportunities and mentoring programs that begin in the summer and continue through the academic year can provide valuable research experience.

- **Faculty involvement and leadership.** Like undergraduate-focused collaborations, graduate- and doctoral-focused collaborations rely on building trust and respect between institutions. Effective master's and PhD collaborative programs, however, are even more dependent on relationships between faculty members to connect with participating students and work with their colleagues at the collaborating institution. Because of their deep involvement

[120] EINAUDI, note 115, above, at 1.

[121] Roli Varma & Lisa M. Frehill, *Introduction to Special Issue on Science and Technology Workforce*, 53 AM. BEHAVIORAL WORKFORCE 943, 944 (2010).

[122] *Id.*

© American Association for the Advancement of Science, 2012

with students and their research, faculty members are the most natural and likely leaders of graduate and doctorate collaborative programs. While developing programs, professors should explain their mission, program design, and goals clearly and deliberately to institutional leadership.[123]

- **New faculty recruitment.** Participating institutions have an opportunity not only to increase student diversity in their programs and garner additional research funding but also to attract talented faculty members, both junior and senior, who have an interest in increasing diversity in STEM programs by attracting new pools of student talent as well as pursuing their own research. These driven, passionate professors are often interested in solving intrinsic problems in STEM disciplines, and collaborative agreements can give them significant opportunities to visit collaborating institutions, work with a broader pool of talented students and colleagues, and pursue new solutions.

- **Financial aid.** Graduate and doctoral students are usually dependent on institutional financial support, and it is especially important to determine whether financial aid is portable between collaborating institutions. Research assistantships are considered to be of greater value to the student because they provide research experience that is important in STEM fields. Identifying and arranging opportunities for such assistantships, with their attendant stipends, health benefits, and tuition waivers, is critical for the student's ability to complete their advanced degree program. If students can take their financial aid package with them or benefit from an equivalent package at the receiving institution when they transition to the next step of their academic program, they are more likely to succeed.

For graduate and doctoral programs, relationships between departments are highly important. Collaborating institutions should share academic or research programs to facilitate dialogue and interaction between participating faculty members and students. The Fisk-Vanderbilt Master's-to-the-PhD Bridge Program, featured below, was possible partly because the two institutions already had an agreement of understanding that supported cross-registration in graduate programs in the physical sciences.[124] With this groundwork in place, an enterprising young Vanderbilt faculty member was able to build what is now a highly effective STEM pipeline program.

The territory for this type of collaborative agreement is largely uncharted, such that institutions have the power to address their own needs through arrangements tailored to their specific contexts with a focus on opportunities for students to earn valuable credentials and promote expanded research output. Moreover, developing innovative institutional relationships presents schools with the opportunity to serve as leading examples for other institutions to follow.

---

[123] Telephone interview with Director, Fisk-Vanderbilt Master's-to-the-PhD Bridge Program (Aug. 5, 2011).

[124] *Id.*

© American Association for the Advancement of Science, 2012

The development of the advanced degree program collaborative agreement landscape is nascent, meaning that institutions will not have as many models and examples to use for structuring their own agreements. And because these programs attract a relatively small number of students, they may not receive the same close attention given to their undergraduate-focused counterparts. Nevertheless, STEM graduate and doctoral programs will train the nation's future scientific and technical innovators, so institutions should give the same close attention to the development of these programs as any other student transitions program. Faculty members can be highly creative and are likely the key to the success of these programs. Provosts and deans can work proactively with faculty members to build ideas for collaborations at the graduate and doctoral levels.

Collaborative agreements focused on graduate and doctoral students can be clustered into three broad types: (a) recruitment initiatives sponsored by multiple institutions; (b) pathways to advanced degrees; and (c) research opportunities that benefit students, faculty, and institutions alike.

Recruitment Initiatives

Current strategies to attract candidates to advanced degree programs usually rely on informal connections between professors or the individual efforts of prospective students. Developing collaborative recruitment strategies can increase student diversity by introducing students to programs they never may have considered. Several recruitment areas of focus merit consideration, including faculty relationship-building, student and institutional database development, and engagement with STEM-focused organizations.

Faculty relationship-building

Many effective recruitment strategies for advanced degree candidates depend on personal and professional relationships between faculty members because the nature of the STEM advanced degree programs already depend on close working relationships between students and faculty members. Provosts and deans at institutions interested in collaboration can encourage their faculty members to increase engagement with their counterparts at potential partnering institutions. Strategies to facilitate relationships include providing financial incentives for collaborations, sending faculty members to professional conferences, or facilitating visiting professorships in departments or on specific research projects. Many STEM students credit the mentorship of a single faculty member as the most important reason why they chose a STEM research career.[125]

Student and institutional database development

Well-developed databases can serve as effective tools in helping identify and recruit promising STEM undergraduates into advanced degree programs. These databases can compile student information from national or regional STEM conferences, undergraduate research competitions, and scholarship programs. An effective recruitment database can provide key

[125] *See* Linda S. Behar-Horenstein, Kellie W. Roberts, & Alice C. Dix, *Mentoring Undergraduate Researchers: An Exploratory Study of Students' and Professors' Perceptions*, 18 ROUTLEDGE 269 (2010).

© American Association for the Advancement of Science, 2012

sources of meaningful data for institutions from which they can identify promising students as well as potential collaborating institutions.[126]

Focus on Innovative Recruitment Strategies

An Electronic Recruitment Consortium

Potential participants: Any number of interested public and private colleges and universities with STEM academic programs as well as industrial and business leaders

The host institution, which could be a non-profit organization or a leading college or university, would create a new electronic Recruitment Consortium on social networking sites (including Facebook or a new, member-only networking website) to increase participation of students, including those from under-represented groups in STEM graduate programs and academic and industrial careers. Once established, the Consortium will include searchable databases of prospective STEM graduate students and host focus and interest groups to make new connections between students, faculty, and employers.

Colleges, universities, STEM-research supporting government agencies, and corporations will sign a group consortium agreement and pledge to support maintenance and development of the Consortium through small annual membership fees. Institutions also will commit to contribute information to the database in order to provide a comprehensive survey of academic programs in STEM for interested students to access. Any interested students in specified STEM disciplines at participating institutions will be given the opportunity to input their information into the database using institution-provided individual passwords. Additionally, member institutions can use the Consortium to target potential collaborative partners and build new bilateral agreements to increase student access to recruitment.

For a complete overview of the recruitment consortia model, including a more detailed description and sample contractual language, see Appendix D.

Engagement with STEM-focused organizations

Recruitment programs can engage external groups to draw new talent to graduate and doctoral programs. For example, using resources of minority-focused STEM professional organizations

[126] Data collection always raises some privacy concerns, so institutions should take care to protect students' information. Institutional leadership and counsel may need to consider ways to attain student permission for the collection and use of personal data for any collaborative agreement-related efforts. When developing recruitment initiatives, institutions and their organizational partners should consider how student privacy will be respected. For example, students who participate in conferences, competitions, or scholarship programs may need to sign consents to disclosure of personally identifiable information prior to listing in recruitment databases. Similar agreements already are used by educational testing services to help high-scoring students connect with institutions. On the federal level, the Family Educational Rights and Privacy Act (FERPA), as a general rule, prohibits educational institutions from sharing students' personal data without consent from students and/or their parents. 20 U.S.C. § 1232g (2010). State privacy and non-disclosure acts also may apply.

© American Association for the Advancement of Science, 2012

and national STEM grant funders, institutions can reach a wider variety of students. The recruitment strategy of the Fisk-Vanderbilt Master's-to-the-PhD Bridge Program, discussed below, includes aggressive engagement with minority-representing organizations such as the National Society of Black Physicists and the National Society of Hispanic Physicists. At these organizations' annual conferences, Fisk-Vanderbilt representatives host meetings, serve as judges for student research competitions, and operate mentoring tables in hopes of identifying and attracting talent. Not only do Fisk-Vanderbilt recruiters encourage graduating college seniors to apply to the Pathway program, they also offer promising sophomores and juniors the opportunity to spend a summer as interns at Fisk and Vanderbilt research facilities. These recruiting efforts mean that when applications for the Pathway program are received, admissions staff and faculty members almost always already know the prospective students and, therefore, can make more accurate determinations on applicants' likelihood of success in the program.

Pathways to Advanced Degrees

Advanced credentials are necessary for entry into STEM research professions.[127] With a history of low participation by women and underrepresented minority students, new degree programs – especially those that enhance preparation for a PhD program like the "master's bridge" programs described below – can attract and retain a wider variety of students in the STEM research community.

To entice students into graduate STEM programs, some advanced degree programs target undergraduates before they earn their baccalaureate degrees. These collaborations offer easy access to master's degree programs for students who are working toward STEM baccalaureate degrees. These programs mirror undergraduate 3+2 programs, but instead of earning two baccalaureate degrees, students earn a baccalaureate degree from the transferring institution and a master's degree from the receiving institution. During their junior or senior year, students usually take some graduate-level courses at the receiving institution to prepare for the master's program.

[127] Professional degree and certificate programs will not be included in this discussion, even though they also attract STEM undergraduate students. Instead, this paper's purpose and scope target strategies, programs, and agreements that bring STEM undergraduates into research-based master's and PhD programs.

© American Association for the Advancement of Science, 2012

Focus on Collaborations among Computer Science Programs

Georgia Tech's College of Computing and Spelman College[128]
Baccalaureate-granting institutions: All-Women's HBCU
Master's-granting institution: Public research

Georgia Tech's College of Computing is developing an agreement with Spelman College, the elite all-women's HBCU, that will allow students to receive their baccalaureate degree in computer science from Spelman and their master's degree in computer science from Georgia Tech with just one year of additional study. The institutions' shared location in Atlanta, Georgia, helps make this agreement possible. Rather than offering a single baccalaureate degree from Georgia Tech,[129] the computer science agreement allows Spelman to support its own computer science department while also giving students an opportunity to earn a master's degree from Georgia Tech, home to one of the nation's top ten computer science programs.

Further up the pipeline, some students enter a PhD program after the completion of an undergraduate degree, while others earn a master's degree before starting a doctoral degree. Students from underrepresented minority populations are more likely to take the latter path and access different institutions for their master's and PhD degrees.[130]

The "master's bridge to the PhD" programs are designed with this demographic trend in mind. Through this type of collaborative agreement, STEM undergraduate students apply to a master's degree program at one school (which will serve as the transferring institution) with the understanding that successful completion of the master's program will help fast track them to PhD programs at another school (the receiving institution). Both the transferring and receiving institutions will be involved in the student's master's degree program through cross registration for courses at both institutions, mentoring opportunities with faculty from both institutions, and – most importantly – research opportunities that involve faculty and facilities from both institutions. These programs are ideally suited for promising STEM students who are interested in but not ready for PhD programs when they graduate from their undergraduate institution. A one- or two-year master's degree program can develop students' research skills and give

[128] Telephone interview with Associate Dean, College of Computing, Georgia Institute of Technology (June 29, 2011).

[129] Because its Atlanta University Complex (a group of HBCUs in the Atlanta area) counterparts have their own computer science departments, Georgia Tech's College of Computing did not choose to structure its program like the College of Engineering's transfer programs. Discussed above in Section III.A., Georgia Tech's engineering transfer programs award a single engineering baccalaureate degree to participating students.

[130] Keivan G. Stassun, Arnold Burger, & Sheila E. Lange, *The Fisk-Vanderbilt Masters-to-PhD Bridge Program: A Model for Broadening Participation of Underrepresented Groups in the Physical Sciences through Effective Partnerships with Minority-Serving Institutions*, 58 J. GEOSPATIAL EDUC. 135, 136 (2010) (citing Sheila E. Lange, "The Role of Masters Degree Transitions on PhD Attainment in STEM Disciplines Among Students of Color", PhD Thesis, University of Washington (2006)).

© American Association for the Advancement of Science, 2012

institutions a new, potentially more predictive measure for admissions to PhD programs. Rather than relying on GRE scores, on which underrepresented minorities are statistically more likely to have lower scores,[131] an institution with STEM PhD offerings can observe and train potential doctoral candidates as they prepare for admission.

<u>Focus on Collaborations among Graduate and Doctoral Programs</u>

The Fisk-Vanderbilt Master's-to-the-PhD Bridge Program[132]
Master's-granting institution: Private HBCU
PhD-granting institution: Private research

The Fisk-Vanderbilt Master's-to-the-PhD Bridge Program is a partnership between two institutions in Nashville, Tennessee – Fisk University, a private HBCU, and Vanderbilt University, a private research institution. Participating departments identify promising students from colleges and universities nationwide who might fall through the cracks without mentorship and support. Overwhelmingly, participating students are not Fisk or Vanderbilt undergraduates. Instead, the program targets students at MSIs across the country through an array of recruitment mechanisms that include outreach to faculty members, sponsorship of summer undergraduate interns, and participation in STEM conferences and research competitions that include undergraduates.

The Bridge Program gives full funding support to students with STEM undergraduate degrees who are interested in pursuing PhD programs in physics, astronomy, materials science, biology, or biomedical sciences but need more coursework, research experience, or training before applying. Students accepted into the program spend two years completing a master's degree at Fisk with full access to instructional and research opportunities at both institutions in preparation for entry into PhD programs. Through mentoring from faculty members and

[131] Laura Perna, Valerie Lundy-Wagner, Noah D. Drezner, Marybeth Gasman, Susan Yoon, Enakshi Bose, & Shannon Gary, *The Contribution of HBCUS to the Preparation of African American Women for STEM Careers: A Case Study*, 50 RESEARCH IN HIGHER EDUC.1, 3 (2008) (*citing* M.T. Nettles & C.M. Millet, *The human capital liabilities of underrepresented minorities in pursuit of science, mathematics and engineering doctoral degrees*, MAKING STRIDES: RESEARCH NEWS ON MINORITY GRADUATE EDUC. (1999)); *see also* David Lubinski, *Spatial ability and STEM: A sleeping giant for talent identification and development*, 49 PERSONALITY & INDIVIDUAL DIFFERENCES 344 (2010) (arguing that the GRE is an insufficient measure of STEM potential because it does not measure spatial intelligence).

[132] Keivan G. Stassun, Arnold Burger, & Sheila E. Lange, *The Fisk-Vanderbilt Masters-to-PhD Bridge Program: A Model for Broadening Participation of Underrepresented Groups in the Physical Sciences through Effective Partnerships with Minority-Serving Institutions*, 58 J. GEOSPATIAL EDUC. 135 (2010); Daryl Chubin, *Eye on Ph.D production (Part 2): The Fisk-Vanderbilt 'Miracle,'* AAAS.ORG (June 14, 2011), http://membercentral.aaas.org/blogs/stemedu/eye-phd-production-part-2-fisk-vanderbilt-miracle; Fisk-Vanderbilt Masters-to-the-PhD Bridge Program, Program Description, http://www.vanderbilt.edu/gradschool/bridge/descript.htm (last visited Aug. 3, 2011); and telephone interview with Director, Fisk-Vanderbilt Pathway to the PhD Program (Aug. 5, 2011).

© American Association for the Advancement of Science, 2012

relationships with students who share their goals and interests, participating students become full members of the STEM academic community. Students who successfully complete the program get fast-track acceptance into a corresponding Vanderbilt PhD program. In the seven years of the collaborative program's existence, 50 graduate students have been supported, 88% of whom were underrepresented minorities and 55% of whom were women. All program graduates received offers from a Vanderbilt PhD program and most accepted, although a few accepted other offers at other schools. For example, one graduate of the program won an NSF graduate grant and is on track to become the first female, African-American graduate of the Yale Physics PhD program.

Both Fisk and Vanderbilt have reaped valuable benefits. In the seven years of the program's existence, Fisk has seen a 300% increase in intramural research grant awards. Vanderbilt has received $30 million in external funding, including six prestigious NSF Career Grants. Moreover, both institutions have gained national recognition for establishing and maintaining an effective solution to the complex challenge of getting more students from underrepresented populations onto the STEM research track.

Research Opportunities

STEM advanced degree programs depend on the development of students' research abilities. Institutions can collaborate to provide valuable research opportunities and important contacts to students regardless of whether or not those students earn degrees from their host institution. In addition to student-focused collaborations, institutions may find commonalities in their research programs. Students and faculty alike can share in the benefits of joint efforts in cancer research, materials science, energy development, or other STEM research initiatives. Several research-based collaborations already exist and are stretching across borders to include collaborations among American institutions and international partners. British Prime Minister David Cameron's Connect UK-US Partnership Scheme is one current example. Under this initiative, the British Council of North America recently awarded 37 American institutions with a grant to collaborate and share research activity with British, Indian, Chinese, and/or Italian institutions.[133] One grant for engineering research went to City University London and a highly diverse group of American counterparts – a private research-focused university on the east coast (Northeastern University), a public research university in the Midwest (University of Wisconsin – Madison), and a community college on the west coast (Santa Monica Community College).[134] As the Director of British Council North America explained, "Multilateral collaborations are a key aspect to the future of international higher education. While US and UK institutions have a long history of academic exchanges and close collaboration, we need to

---

[133] Grantees included Arizona State University, Emory University, Georgia Tech, Georgetown University, Stanford University, University of South Florida, and Yale University. *37 Universities Start New Partnerships with UK, India & China Links*, BRITISH COUNCIL: UNITED STATES OF AMERICA (Jan. 28, 2011), http://www.britishcouncil.org/usa-about-us-newsroom-press-releases-new-partnership-fund-recipients.htm.

[134] *City University London builds stronger links with US institutions*, CITY UNIVERSITY LONDON (Aug. 4, 2011), http://www.city.ac.uk/news/2011/august/city-university-london-builds-stronger-links-with-us-institutions.

© American Association for the Advancement of Science, 2012

re-energize our partnerships by working together with other countries in groundbreaking science and technology fields."[135]

[135] *37 Universities*, note 133, above.

© American Association for the Advancement of Science, 2012

Section IV. *Enhancing Connectivity:* Key Components of Maximized Collaborative Success

Signing an agreement or set of agreements is only the first step to building new STEM pathways. Strategies and policies that augment and complement a collaborative agreement can help ensure that the goals of the collaborative agreements are met. The development of those strategies and policies should, at a minimum, center on: (A) data collection and analysis; (B) STEM curricular pathways; and (C) communication and coordination between institutions and students. Although none of these recommendations reflects novel thinking, each highlights an area of too frequent inattention – resulting in less than optimal institutional success.

The Smart Grid: Developing Smaller-Scale Initiatives

The electrical Smart Grid includes complementary mechanisms like electronic meters on homes to provide the system with more data and give greater autonomy to individual energy users. The Smart Grid for institutions and their students also should include a variety of supplementary strategies to enhance opportunities and promote achievement in STEM. Particularly effective strategies use technology effectively and respond to the various needs of increasingly diverse populations of students.

A. The Collection and Analysis of Institution-Specific Data to Monitor Student Progress and Program Efficacy

An effective collaborative agreement is grounded in specific goals that link institution-specific challenges with the resources available at a collaborating institution. Thus, the first step an institution must take toward the establishment of a collaborative agreement involves an internal review of existing programs and the identification of gaps within student achievement in STEM disciplines. To understand the context and nature of those gaps, a robust review of relevant data is required. Although most institutions maintain databases of student information, faculty members often do not maximize the use of this information when developing academic programs. This data, however, can reveal populations of students who could succeed in STEM if properly identified, recruited, and supported.[136] For example, before starting the Bridging the Valley program, featured below, faculty leaders worked with institutional researchers to see which students started out with an interest in STEM but did not complete STEM degree programs.[137] With the understanding that many students lacked the math skills needed to succeed in STEM academic programs, faculty members then were able to craft a summer bridge program that focused on building student math skills (especially in algebra), while also exposing students to a host of STEM disciplines, and forming community among students, upperclassmen, and faculty members.

---

[136] For a discussion of privacy concerns, see note 126, above.

[137] Phone interview with Program Director, Bridging the Valley (Aug. 8, 2011).

© American Association for the Advancement of Science, 2012

The strategic use of data also can aid operations and administration of certain programs. Consider the UTEP-EPCC reverse transfer program, featured in Section II. The idea for the program arose when UTEP administrators started paying more attention to their institutional data. They discovered that many students were transferring credit from EPCC to go toward degrees at UTEP, but EPCC was not getting credit for initially hosting those students and the students were not earning any credentials for their time there. Responding to those data points and policy concerns, UTEP established a mechanism that allowed EPCC transitioning students to use UTEP credits to go towards EPCC associate's degrees. The system became even more effective once UTEP administrators were able to set up computer systems to help them monitor students' progress. Now, a single data scan shows the current UTEP students who have earned at least 15 credits at EPCC and are eligible to complete an EPCC associate's degree at UTEP. Automated identification of associate's degree candidates eliminates human error, ensures timely status notification to students, and allows both institutions to remain up-to-date on the program's progress. As a result of the automated system, 1,166 students received associate's degrees in 2010 – more than three times as many as the year before, when administrators were identifying degree candidates by hand.[138]

Finally, data analysis can demonstrate program efficacy, which often is crucial for grant funding and generating support from institutional leadership. It is important for collaborating institutions to include provisions in their agreements for regular collection and analysis of student- and faculty-provided data so that programs can continue to grow and improve.

B. The Establishment and Enhancement of STEM Curricular Pathways

STEM courses are difficult, especially the introductory "weed out" requirements. This is especially true during the first two years of undergraduate study, when poor performance in STEM classes is a leading reason why students leave those disciplines.[139] This trend is especially important for underrepresented groups that, on average, have greater struggles with grades.[140] For example, fear of poor academic performance in STEM courses has been shown to affect female students more acutely.[141] For transitioning students from community colleges – most of

[138] Lumina Found., *El Paso colleges link up to lift students*, FOCUS, Spring 2011, at 13.

[139] Student experiences during their first two years seem to have the most significant impact on their decision to persist. Students are more likely to remain in a STEM field major as the ratio of their grades earned in STEM courses to grades earned in non-STEM courses increases. Amanda L. Griffith, *Persistence of Women and Minorities in STEM Majors: Is it the School That Matters?* 17 (Cornell Higher Educ. Research Inst., Working Paper No. 122, 2010), http://digitalcommons.ilr.cornell.edu/workingpapers/122.

[140] Donald F. Whalen & Mack C. Shelley, II, *Academic Success for STEM and Non-STEM Majors*, 11 J. STEM EDUC. 45, 51 (2010); Nat'l Ctr. for Educ. Statistics, U.S. Dep't of Educ. (2009) (While white and Asian students tend to have 3.0 or higher GPAs as undergraduates, about a third of black, Latino, and American Indian students have lower than 2.5 GPAs.).

[141] Researchers found that "most noteworthy gender difference was the influence of students' expected academic difficulty . . . If females and Latinas, in particular, are more affected by perceptions of how hard their major will be then educators need to emphasize activities that alleviate this stress or facilitate female students' involvement in the supportive practices that they value." *Id*. at 54.

© American Association for the Advancement of Science, 2012

whom experience a dip in GPA during their first term at a receiving school – poor performance in STEM classes might convince them that a baccalaureate degree is not worth their time.

<u>What is the Transfer Gap?</u>

Transitioning students often face some academic difficulty as they adjust to the receiving school. Termed the "transfer gap" or "transfer shock," the trend describes the tendency of transitioning students to have lower academic performance during their first term at a new school, often due to a combination of academic, social, and cultural differences between campuses.[142] These students, however, almost always rebound academically if they stick with their academic program past the first term.[143]

Many students from underrepresented minority groups experience an additional difficulty: the "transfer *choice* gap." This occurs when a student is academically eligible for transfer into a competitive school but, due to institutional, personal, or cultural barriers, opts to transfer to a less selective school or not to transfer at all.[144]

Though most research and commentary on the transfer gap applies to the transition of community college students to four-year institutions, the lessons may be applied to a variety of transitional pathways, including the transitions in 3+2 agreements and advanced degree programs. Receiving institutions should be especially aware of this problem, and consider ways to ease students' transition as they form collaborative relationships with transferring schools.

These problems are not insurmountable. Studies show that even small academic gains can be the difference between whether a student decides to remain in a STEM field or not.[145] Institutions should acknowledge these problems and offer programs to help students through these introductory courses to get them on the path to STEM degree attainment.

Building Academic Skills and Enhancing Exposure to STEM

Schools are developing promising practices to address these disparities in student achievement in STEM. Summer bridge programs, academic year programs, flexible ways to earn credit, and

---

[142] Tatiana Melguizo, Gregory S. Kienzel, & Mariana Alfonso, *Comparing the Educational Attainment of Community College Transfer Students and Four-Year College Rising Juniors Using Propensity Score Matching Methods*,82 J. HIGHER EDUC. 265, 268 (2011).

[143] Telephone interview with Eng'g Educ. Outreach Director, Coll. of Eng'g, Ga. Inst. of Tech. (June 24, 2011).

[144] Estala Mara Bensimon & Alicia Dowd, *Dimensions of the Transfer Choice Gap: Experiences of Latina and Latino Students Who Navigated Transfer Pathways*, 79 HARV. EDUC. R. 632, 635 (2009).`

[145] For every one-tenth of a GPA point higher, a student is "91.7% more likely to graduate or be retained at year six than not graduate or be retained . . . This result suggests a very strong effect of higher cumulative GPA on retention/graduation, controlling for the effects of other predictors." Whalen, note 140, above, at 51.

© American Association for the Advancement of Science, 2012

innovative course delivery methods can all help spark student interest in STEM and help them develop the skills they need to succeed in a degree program.

Many institutions offer **summer bridge programs** for rising freshmen that seek to "bridge" high school and college. During the summer before their first semester, participating students live on campus, take summer classes to build science and math skills, and learn what it takes to be successful in STEM fields. Some programs offer students a small stipend to participate; most programs ensure that the credits earned during summer bridge courses go toward the students' credit requirements. In addition to the academic benefits, students get comfortable on campus and with faculty and other students, thus easing the transition from high school to college.

Although many summer bridge programs target rising freshmen, other summer bridge programs have been designed for incoming transfer students. The University of California – Irvine offers multiple summer programs which help transitioning students build a solid academic and personal foundation before their first quarter begins.[146]

Focus on Summer Bridge Institutional Collaborations

Bridging the Valley Program

Participating institutions: State university, private liberal arts colleges, community college

In Harrisonburg, Virginia, James Madison University, Eastern Mennonite University, Bridgewater College, and Blue Ridge Community College have collaborated to provide a shared summer bridge program for rising freshmen interested in STEM majors with the support of an NSF grant.[147] The program marks the first time that all four institutions have worked together formally. Students accepted into the program from all four institutions spend three weeks studying on all four campuses and receive an $800 stipend for successful completion of the program.[148] Students are also eligible for an additional $800 stipend for participation in programs at their home institution during the academic year that develop academic skills and build the STEM community.[149] Each participating institution structures academic year programming differently, but all focus on building STEM academic skills and strengthening the STEM community. To qualify for the stipend, students must meet basic grade requirements for math courses and maintain a "Science Lab Notebook" for science sessions. The notebook policy is designed to develop proper science habits by requiring students to prepare thoroughly for experiments before setting foot inside the lab.[150]

---

[146] Transfer Summer Start Program, Univ. of Cal. – Irvine: Summer Session, *You are invited to take part in the Transfer Summer Start Program*, http://www.summer.uci.edu/transfer/ (last visited Aug. 16, 2011).

[147] Bridging the Valley: A STEP Ahead for STEM Majors, James Madison Univ., *Summer Bridge Program 2011* (June 9, 2011), http://www.jmu.edu/stem/btv/summerbridge.html (last

[148] *Id.*

[149] Bridging the Valley, Stipend Explanation, http://www.jmu.edu/stem/btv/pdf/StipendExplanation2011.pdf.

[150] *Id.*

© American Association for the Advancement of Science, 2012

In addition to student-focused programs, Bridging the Valley also includes a significant amount of professional development opportunities for faculty members from all of the participating schools. Approximately 80 faculty members have participated in the programs, and program leaders hope to continue this part of the project after the NSF grant expires.

During the program's three years of existence, it has seen significant results: three-quarters of the first summer bridge participants continue to pursue STEM degrees after two years. As a result of the array of student- and faculty-focused strategies, retention in STEM fields is up 26% across all four schools.

STEM academic programs demand much of their students. The transition into a degree program – whether as an entering freshman or a transfer student – can be difficult. Institutions can help students transition and excel in their STEM courses through **academic year programs** that focus on improving math and science skills and building community among STEM students and faculty members. Some institutions create special curricular offerings, while others focus on extra-curricular programs and opportunities.

Focus on Academic Year Programs that Build STEM Skills

Tools for Success Program at Miami Dade College (MDC)[151]
Participating Institution: Public community college

Since 2007, MDC has used the Tools for Success (TFS) program to increase retention, transfer, and graduation rates of underrepresented groups in STEM disciplines. Eligible students take four one-credit courses which help them learn success strategies in STEM fields. Each of these courses is tuition-free. Students also receive personalized academic advising, a $1,000 service award, an iPod, and the chance to earn a $2,000 transfer scholarship. TFS has shown early signs of progress: it retains more than 80% of its students, 75% of whom receive their associate's degrees and transfer to a four-year institution. TFS students also have significantly higher GPAs than their peers. These numbers are even more impressive when compared to the 27% overall STEM degree completion rate at MDC. TFS shows that personalized attention, skills-focused learning, and targeted financial aid can produce significant results in STEM.

Expanding Credit Options through Prior Learning Assessments

Students of the 21st Century have diverse backgrounds and motivations for pursuing higher education. A growing segment of that diverse student population is made up of non-traditional students.[152] Though transfer and graduation rates tend to decrease with age,[153] many adults

---

[151] Tools for Success, Dep't of Natural Scis., Health, & Wellness, Miami Dade Coll., *About the Program*, http://www.toolsforsuccess.org/toolpages/abouttheprogram.html (last visited July 26, 2011); Lumina Found., *TFS shapes scientific minds*, FOCUS, Spring 2011, at 25. This paper discusses MDC at page 39, above.

[152] A non-traditional student usually starts a degree program later in life and is more likely to have financial and personal commitments outside of school. For the Department of Education's comprehensive definition, see note 64, above.

© American Association for the Advancement of Science, 2012

enter institutions of higher education with meaningful professional, military, or technical experience. Institutions should consider new ways for students to receive credit for prior experience and to earn credit more flexibly.

Prior learning assessments (PLAs) offer institutions a way to award college credit for prior learning or professional or military experience.[154] A 2010 study of institutions using PLAs as assessment tools found that students who earned PLA credit were significantly more likely to earn degrees: 56% of students with PLA credit earned an associate's or baccalaureate degree, compared to the 21% of students without PLA credit.[155]

Institutions have many options for granting PLA credit:

- Standardized examinations that test student experience and knowledge content are the most common PLA mechanisms. Many programs, including Advanced Placement and International Baccalaureate exams, target high school students. Military personnel and veterans can receive funding from the Defense Department to take the tests administered by the College-Level Examination Program.

- Individual student portfolios are evaluated by faculty members or admissions officers with appropriate subject matter expertise.[156] Earning this credit is not easy; students usually have to prepare detailed applications and interview with faculty members to support their case.[157]

- Retroactive award of credit to non-credit courses of programs. Community colleges offer non-credit learning opportunities and many of these non-credit classes have for-credit analogs at four-year institutions. At least 17 states have adopted policies that retroactively award credit at a four-year institution to non-credit courses or programs completed at a two-year institution.[158]

Most institutions offer at least one form of PLA; many offer a suite of options. By giving students the ability to align their knowledge base with their degree programs, institutions allow

---

[153] BPS:2009.

[154] Rachel Aviv, *Turning Life Experience into College Credit*, N.Y. TIMES (Oct. 30, 2008), http://www.nytimes.com/2008/11/02/education/edlife/strategy.html.

[155] REBECCA KLEIN-COLLINS, AMY SHERMAN, & LOUIS SOARES, CTR. FOR AM. PROGRESS, DEGREE COMPLETION BEYOND INSTITUTIONAL BORDERS: RESPONDING TO THE NEW REALITY OF MOBILE AND NONTRADITIONAL LEARNERS 24, fig. 3 (2010) (citing REBECCA KLEIN-COLLINS, COUNCIL FOR ADULT & EXPERIENTIAL LEARNING, FUELING THE RACE TO POSTSECONDARY SUCCESS: A 48-INSTITUTION STUDY OF PRIOR LEARNING ASSESSMENT AND ADULT STUDENT OUTCOMES (2010)).

[156] *Id.* at 24.

[157] At DePaul University in Chicago, students are required to take a six-credit-hour class to develop their portfolios. Aviv, note 154, above.

[158] Klein-Collins, Sherman, & Soares, note 155, above, at 25.

© American Association for the Advancement of Science, 2012

learners to spend their time with new concepts and ideas, rather than having to re-learn something they already have mastered.

<u>Focus on Individualized Curriculum and Academic Majors</u>

City University New York (CUNY) Baccalaureate for Unique and Interdisciplinary Studies[159]
Host Institution: Public four-year

Since 1971, CUNY Baccalaureate has offered motivated, often nontraditional students the opportunity to earn a baccalaureate degree outside of the traditional academic major system. The program targets students who already have started degree programs but feel constrained by traditional academic major programs. Students are awarded credit both for credits earned at other accredited institutions and, on a case-by-case basis, for personal or professional experience. To gain admission into the program, students must propose area(s) of concentration and prepare a detailed personal statement about how the proposed area(s) of concentration relate to their academic and professional goals. STEM-focused concentrations have included renewable energy, web design with motion graphics and 3D animation, and applied statistics.

About 600 part-time and full-time students are enrolled in the program. More than half are women, and about three-quarters are more than 25 years old. Students often report that, before discovering this innovative program, they were considering leaving their degree programs because they could not achieve their academic goals. The program's success shows that non-traditional students are more likely to succeed when academic programs can be adapted to students' needs, rather than forcing students to adapt to the program's demands.

Enhancing Course Delivery through Online Learning

Online and distance learning, which allows students to complete course work at home, can make otherwise impossible degree attainment a reality – especially for non-traditional students. Online courses and supplementary programs also can provide new methods of assessment and evaluation of student progress. Carnegie Mellon's Open Learning Initiative (OLI) uses an innovative web-based curriculum that embeds an assessment exercise within every student activity. The courses are available, free of charge, to the public, and cover many fields of study, with a focus on STEM.[160] Other institutions can use the curriculum to supplement existing courses or offer additional courses for credit towards their degree programs.[161] Initial studies of OLI course have returned positive results. In a statistics course

[159] City University New York Baccalaureate for Unique and Interdisciplinary Studies, *Fast Facts,* http://cunyba.gc.cuny.edu/fastfacts/#enrollment (last visited Aug. 10, 2011).

[160] Courses in engineering, statistics, biology, biochemistry, chemistry, economics, physics, empirical research methods, and computational discrete mathematics are available through the OLI. OPEN LEARNING INITIATIVE, http://oli.web.cmu.edu/openlearning/ (last visited Aug. 16, 2011).

[161] *Id.*

© American Association for the Advancement of Science, 2012

that blended OLI material and traditional instruction, students learned as much or more as those in a traditional course, did so in half the time as a traditional course, and tested better than traditional students on retention evaluations given a semester later.[162]

Online learning represents an opportunity not only to provide more flexibility for students but also to extend the reach and influence of institutions and their faculty members. Consider the rapid expansion and public dissemination of TEDTalks, an online catalog that gives the public open access to a host of engaging, informative speeches given at invitation-only TED conferences. Launched in 2007, the TEDTalks site currently is visited 15 million times per month by users in 70 countries.[163] Institutions could use a similar model featuring their faculty members. In fact, Stanford University's Computer Science Department is piloting a set of courses that are free and available to the public.[164] The initial public response has been staggering: For a computer science course on artificial intelligence, 58,000 students in more than 175 countries signed up.[165] Clearly, the public is engaged and interested in STEM research and development, and institutions should explore how to encourage and sustain that interest.

C. Communication and Coordination of Mentoring and Advising Efforts

Students often face a range of options and challenges as they pursue STEM degrees, and institutions can help ensure students' success through coordinated mentoring and advising programs. Recruitment officers, counselors, faculty members, and student mentors can be crucial agents to help students understand what is required to complete a STEM degree and where to seek help if they start struggling.

Academic planning is key to keeping students on track, especially those in STEM disciplines. Giving students easy access to transfer opportunities and policies through websites or print materials encourages students to map out their academic pathway early, preferably before their first semester even starts. Georgia Tech, for example, automatically sends letters regarding transfer policies and requirements to students who do not gain admission as freshmen.[166] Most institutions include information for transfers on their websites; many include specific guidelines on course equivalencies. Additionally, several states, including Alabama, Arizona, California, Florida, New Jersey, New York, and Pennsylvania, have online

[162] Open Learning Initiative, *OER11 Further Reading: More Students, New Instructors: Measuring the Effectiveness of the OLI Statistics Course in Accelerating Student Learning*, http://oli.web.cmu.edu/openlearning/initiative/68-buzz/255-oer11-further-reading-more-students-new-instructors-measuring-the-effectiveness-of-the-oli-statistics-course-in-accelerating-student-learning (last visited Aug. 10, 2011).

[163] TED Initiatives – TED.com, TED, http://www.ted.com/pages/initiatives_ted_com (last visited Aug. 10, 2011).

[164] Although participants will not get Stanford credit, they will be ranked in class performance and given a "statement of accomplishment." John Markoff, *Virtual and Artificial, but 58.000 Want Course*, N.Y. TIMES (Aug. 15, 2011), http://www.nytimes.com/2011/08/16/science/16stanford.html?_r=1&src=me&ref=general.

[165] *Id.*

[166] Telephone interview with Eng'g Educ. Outreach Dir., Coll. of Eng'g, Ga. Inst. of Tech. (June 24, 2011).

© American Association for the Advancement of Science, 2012

tools which link to comprehensive databases of state-based agreements so that students can plan degree paths and determine how their current credits will transfer.

Mentoring can be especially important for female, low-income, or underrepresented minority students who are interested in STEM but lack role models among their family and friends in those fields. Exposure to fellow students and faculty members can open a new world of possibilities for students, especially those who may not know or understand how a collaborative agreement between their home school and another institution could benefit them. Though some students will be able to seek out mentors on their own, not all students will have the ability or willingness to do so. Institutions can help ensure that all students have opportunities to receive guidance and assistance through targeted advising. The University of Texas – El Paso, for example, altered its advising procedures when university officials realized that waiting for semester grades to be posted was too late to reach struggling students. Now, advisors employ "intrusive advising" to reach out to students who seem to be slipping mid-term.[167] For appropriate design and legal justification, institutional leadership should consult with counsel if the program differentiates in the services or benefits it provides based on race, ethnicity, or gender.

Faculty members play a central role in mentoring efforts, and relationships between faculty members at collaborating institutions can help ensure that faculty mentors make their students aware of the options available through the institutions' collaborative arrangements. To facilitate faculty involvement, organizations made up of professors from all participating schools can help an agreement succeed and improve. New York is home to the Two-Year Engineering Science Association (TYESA), a collaborative organization through the State University of New York (SUNY) system with representatives from all community colleges and four-year receiving schools that participate in SUNY engineering transfer programs.[168] Founded in 1993, TYESA helps connect community college and four-year institution faculty. During TYESA's annual meetings, members discuss transfer requirements, curricular changes, and one engineering policy topic. Results include better advising for students, more resources for faculty professional development, and more fluid communication among institutions.[169]

Including administrators and student advisors in collaborative strategies is also important. Georgia Tech, for example, has a dedicated advisor at every partnering institution who can increase student awareness of transfer programs and provide guidance on how to take advantage of those opportunities.[170] And the success of the UTEP-EPCC reverse transfer program relies on EPCC academic advisors' support and willingness to inform students considering transfer to UTEP about the reverse transfer opportunity.[171]

[167] Telephone interview with Dean of Scis., Univ. of Tex. – El Paso (Aug. 9, 2011).

[168] SUNY TYESA, http://www.tyesa.org/ (last visited Nov. 7, 2011).

[169] Telephone interview with Two-Year Eng'g Sci. Ass'n President (June 27, 2011).

[170] Telephone interview with Eng'g Educ. Outreach Dir., Coll. of Eng'g, Ga. Inst. of Tech. (June 24, 2011).

[171] Telephone interview with Dean of Scis., Univ. of Tex. – El Paso (Aug. 9, 2011).

© American Association for the Advancement of Science, 2012

Conclusion

As dramatic demographic, technological, and societal changes continue to define the 21st Century landscape, higher education must keep pace. In that effort, re-examining old paradigms and imagining new possibilities offers great promise for more effectively and efficiently meeting our nation's needs in educating new and diverse cohorts of students who will pursue careers in STEM. In particular, the pursuit of inter-institutional relationships, coupled with coordinated and targeted outreach and student support, that can foster new pathways and promote new opportunities merits serious attention—and it merits that attention now. This paper can serve as a key resource in that endeavor. Only with serious attention – including a rigorous examination of some very fundamental questions that have surfaced in preceding pages – can our nation and its institutions of higher education meet our national goals associated with innovation and success in education, the economy, national security, and civic society.

© American Association for the Advancement of Science, 2012

Appendix A: Bibliography

Referenced Institutions

Featured in boxes:
Blue Ridge Community College (VA)
Bridgewater College (VA)
City University of New York
Claremont Colleges (CA)
Eastern Mennonite University (VA)
Fisk University (TN)
Florida A&M University
Florida State University
Georgia Institute of Technology
James Madison University (VA)
Miami Dade College (FL)
Spelman College (GA)
State University of New York
University of San Francisco (CA)
University of Southern California
Vanderbilt University (TN)

Mentioned in Text:
Arizona State University
Abraham Baldwin Agricultural College (GA)
Albany State University (GA)
Armstrong Atlantic State University (GA)
Atlanta Metropolitan College (GA)
Auburn University (AL)
Boston University (MA)
Carnegie Mellon University* (PA)
Clayton State University (GA)
Columbia University (NY)
Columbus State University (GA)
Dalton State College (GA)
Dartmouth College* (NH)
Drexel University (PA)
Duke University (NC)
Dutchess Community College (NY)
El Paso Community College (TX)
Gainesville State College (GA)
Georgetown University (DC)
Georgia College & State University
Georgia Perimeter College
Georgia Southern University
Gordon College (GA)
Harvey Mudd College (CA)
Macon State College (GA)
Massachusetts Institute of Technology
Michigan State University
Middle Georgia College
Mount Holyoke College (MA)
New York University
North Georgia College and State University
Notre Dame (IN)
Renssalear Institute of Technology (NY)
Savannah State University (GA)
Scripps College* (CA)
Smith College (MA)
Stanford University (CA)
Southern Polytechnic State University, (GA)
University of California – Berkeley
University of Massachusetts – Boston
University of Texas
University of Texas – El Paso
University of West Georgia
University of Wisconsin
Valdosta State University (GA)
Washington University in St. Louis (MO)
Yale University (CT)

* = extended discussion

© American Association for the Advancement of Science, 2012

Reports and Information from Institutions of Higher Education

37 Universities Start New Partnerships with UK, India & China Links, BRITISH COUNCIL: UNITED STATES OF AMERICA (Jan. 28, 2011), http://www.britishcouncil.org/usa-about-us-newsroom-press-releases-new-partnership-fund-recipients.htm.

Academic and Student Affairs, Miami Dade College, *Articulation*, http://www.mdc.edu/asa/articulation.asp (last visited Aug. 16, 2011).

Bridging the Valley: A STEP Ahead for STEM Majors, James Madison Univ., *Summer Bridge Program 2011* (June 9, 2011), http://www.jmu.edu/stem/btv/summerbridge.html.

Bridging the Valley, Stipend Explanation, http://www.jmu.edu/stem/btv/pdf/StipendExplanation2011.pdf.

City University London builds stronger links with US institutions, CITY UNIVERSITY LONDON (Aug. 4, 2011), http://www.city.ac.uk/news/2011/august/city-university-london-builds-stronger-links-with-us-institutions.

Coll. of Eng'g, Fla. A&M Univ. – Fla. State Univ., *Prospective Students – Introduction*, http://www.eng.fsu.edu/prospective/ (last visited July 27, 2011).

COLL. OF ENG'G, FLA. A&M UNIV.- FLA. STATE UNIV., RESEARCH REPORT (2010).
SUNY TYESA, http://www.tyesa.org/ (last visited Nov. 7, 2011).

City University New York Baccalaureate for Unique and Interdisciplinary Studies, *Fast Facts,* http://cunyba.gc.cuny.edu/fastfacts/#enrollment (last visited Aug. 10, 2011).

Fisk-Vanderbilt Masters-to-the-PhD Bridge Program, Program Description, http://www.vanderbilt.edu/gradschool/bridge/descript.htm (last visited Aug. 3, 2011).

The Honors Coll., Miami Dade Coll., *About the Honors College*, http://www.mdc.edu/honorscollege/about.asp (last visited Aug. 16, 2011).

The Honors College, Miami Dade College, *Graduation and Transfers*, http://www.mdc.edu/honorscollege/graduation.asp (last visited Aug. 16, 2011).

Miami Dade Coll., *About Miami Dade College*, http://www.mdc.edu/main/about/ (last visited Aug. 16, 2011).

Miami Dade College, *Transfer Options*, http://www.mdc.edu/main/academics/transfer_options.asp (last visited Aug. 16, 2011).

OPEN LEARNING INITIATIVE, http://oli.web.cmu.edu/openlearning/ (last visited Aug. 16, 2011).

© American Association for the Advancement of Science, 2012

Open Learning Initiative, *OER11 Further Reading: More Students, New Instructors: Measuring the Effectiveness of the OLI Statistics Course in Accelerating Student Learning*, http://oli.web.cmu.edu/openlearning/initiative/68-buzz/255-oer11-further-reading-more-students-new-instructors-measuring-the-effectiveness-of-the-oli-statistics-course-in-accelerating-student-learning (last visited Aug. 10, 2011).

Scripps Coll., *About the Engineering Program*, http://www.scrippscollege.edu/academics/department/engineering/index.php (last visited July 27, 2011).

Thayer Sch. of Eng'g at Dartmouth, *Dual-Degree Program* (Dec. 10, 2010), http://engineering.dartmouth.edu/undergraduate/dual/.

Tools for Success, Dep't of Natural Scis., Health, & Wellness, Miami Dade Coll., *About the Program*, http://www.toolsforsuccess.org/toolpages/abouttheprogram.html (last visited July 26, 2011).

Transfer Summer Start Program, Univ. of Cal. – Irvine: Summer Session, *You are invited to take part in the Transfer Summer Start Program*, http://www.summer.uci.edu/transfer/ (last visited Aug. 16, 2011).

Univ. of San Francisco General Catalog 2011-2012, *3/2 Engineering-Physics Dual Degree Program*, http://www.usfca.edu/catalog/artsci/phys/ddp/ (last visited July 27, 2011).

Viterbi Sch.of Eng'g, Univ. of S. Cal. *3/2 Engineering Program*, http://viterbi.usc.edu/admission/transfer/threetwo.htm (last visited July 27, 2011).

Interviews

Telephone Interview with Associate Dean, Coll. of Computing, Georgia Inst. of Tech. (June 29, 2011).

Telephone interview with Associate Provost, Office for Undergraduate Studies, Univ. of Tex. at El Paso (Aug. 4, 2011).

Telephone interview with Dean of Scis., Univ. of Tex. – El Paso (Aug. 9, 2011).

Telephone interview with Deputy Counsel, Fl. A & M Univ. (July 12, 2011).

Telephone interview with Director, Fisk-Vanderbilt Master's-to-the-PhD Bridge Program (Aug. 5, 2011).

© American Association for the Advancement of Science, 2012

Telephone interview with Eng'g Educ. Outreach Dir., Coll. of Eng'g, Ga. Inst. of Tech. (June 24, 2011).

Telephone interview with Program Director, Bridging the Valley (Aug. 8, 2011).

Telephone interview with Two-Year Eng'g Sci. Ass'n President (June 27, 2011).

Key Resources

Am. Ass'n of Cmty. Colls., *2011 Fact Sheet* (2011).

Am. Indian Higher Educ. Consortium, Who Goes to Tribal Colleges (Oct. 1998), http://www.aihec.org/colleges/documents/WhoGoestoTCU.pdf.

THOMAS BAILEY, D. TIMOTHY LEINBACH, & DAVIS JENKINS, CCRC BRIEF NO. 28: GRADUATION RATES, STUDENT GOALS, AND MEASURING COMMUNITY COLLEGE EFFECTIVENESS (2005), http://ccrc.tc.columbia.edu/DefaultFiles/SendFileToPublic.asp?ft=pdf&FilePath=c:\Websites\ccrc_tc_columbia_edu_documents\332_336.pdf&fid=332_336&aid=47&RID=336&pf=ContentByType.asp?t=1.

Linda S. Behar-Horenstein, Kellie W. Roberts, & Alice C. Dix, *Mentoring Undergraduate Researchers: An Exploratory Study of Students' and Professors' Perceptions*, 18 ROUTLEDGE 269 (2010).

Estala Mara Bensimon & Alicia Dowd, *Dimensions of the Transfer Choice Gap: Experiences of Latina and Latino Students Who Navigated Transfer Pathways*, 79 HARV. EDUC. R. 632 (2009).`

George R. Boggs, Am. Ass'n of Cmty. Colls., *Democracy's Colleges: The Evolution of the Community College in America* 1, Presented at White House Summit on Community Colleges (Oct. 5, 2010). http://www2.ed.gov/PDFDocs/college-completion/01-democracys-colleges.pdf.

ANTHONY CARNEVALE, NICOLE SMITH, & MICHELLE MELTON, STEM (2011), http://www9.georgetown.edu/grad/gppi/hpi/cew/pdfs/stem-complete.pdf

ANTHONY CARNEVALE, NICOLE SMITH, & JEFF STROHL, GEORGETOWN UNIV. CTR. ON EDUC. & THE WORKFORCE, HELP WANTED: PROJECTIONS OF JOBS AND EDUCATION REQUIREMENTS THROUGH 2018 (2010), http://www9.georgetown.edu/grad/gppi/hpi/cew/pdfs/FullReport.pdf.

Anthony Carnevale & Jeff Strohl, *How Increasing College Access is Increasing Inequality, and What to Do About It*, *in* REWARDING STRIVERS 71 (Richard D. Kahlenberg, ed., 2010).

© American Association for the Advancement of Science, 2012

CENTER FOR AMERICAN PROGRESS, ARTICULATION AGREEMENTS AND PRIOR LEARNING ASSESSMENTS: TOOLS TO HELP 21ST CENTURY STUDENTS ACHIEVE THEIR POSTSECONDARY EDUCATION GOALS AND KEEP AMERICA COMPETITIVE (2011), http://www.americanprogress.org/issues/2011/06/pdf/college_credits.pdf.

COMM'N ON COLLEGES, S. ASS'N OF COLLEGES & SCHS., TRANSFER OF ACADEMIC CREDIT: POSITION STATEMENT (approved June 2003), http://www.sacscoc.org/pdf/081705/transfer%20credit.pdf;

COMM'N ON COLLEGES, S. ASS'N OF COLLEGES & S, COLLABORATIVE ACADEMIC ARRANGEMENTS: POLICY & PROCEDURES (approved June 2010), http://www.sacscoc.org/pdf/Collaborative%20Arrangements%20final.pdf.

Alfredo G. de los Santos, Jr., & Gerardo E. de los Santos, *Latino/as and community colleges: A pathway to graduate studies?, in* THE LATINA/O PATHWAY TO THE PH.D (Jeanette Castellanos, Alberta M. Gloria, & Mark Kamimura, eds., 2005).

Alicia C. Dowd, John J. Cheslock, & Tatiana Melguizo, *Transfer Access from Community Colleges and the Distribution of Elite Higher Education*, 79 J. HIGHER EDUC. 442 (2008).

ALICIA C. DOWD, LINDSEY E. MALCOM, & ELSA E. MACIAS, CTR. FOR URBAN EDUC., IMPROVING TRANSFER ACCESS TO STEM BACHELOR'S DEGREES AT HISPANIC-SERVING INSTITUTIONS THROUGH THE AMERICA COMPETES ACT (2010).

EXCELENCIA IN EDUCATION, LIST OF 2009-10 HSIS (2011), http://edexcelencia.org/system/files/hsilist-2009-10.pdf.

Amanda L. Griffith, *Persistence of Women and Minorities in STEM Majors: Is it the School That Matters?* (Cornell Higher Educ. Research Inst., Working Paper No. 122, 2010), http://digitalcommons.ilr.cornell.edu/workingpapers/122.

Stephen J. Handel, *Articulation: The Currency of Transfer?* (Destinations of Choice Initiative: A Reexamination of America's Community Colleges, CollegeBoard, Working Paper No. 3, 2008).

Stephen J. Handel, *Improving Student Transfer from Community Colleges to Four-Year Institutions – The Perspective of Leaders from Baccalaureate-Granting Institutions*, The College Board (2011), http://advocacy.collegeboard.org/sites/default/files/11b3193transpartweb110712.pdf.

CATHERINE HILL, CHRISTIANNE CORBETT, & ANDRESSE ST. ROSE, AM. ASS'N OF UNIV. WOMEN, WHY SO FEW? WOMEN IN SCIENCE, TECHNOLOGY, ENGINEERING, AND MATHEMATICS (2010).

Hispanic Ass'n of Colls. & Univs., *Facts on Hispanic Higher Education*, http://www.hacu.net/hacu/Data,_Statistics,_and_Research.asp?SnID=1234918590 (last visited Aug. 18, 2011).

© American Association for the Advancement of Science, 2012

Hispanic Ass'n of Colls. & Univs., *HACU Member-HSIs Map* (Oct. 18, 2010), http://www.hacu.net/images/hacu/membership/pdf/hsi.pdf.

Kids Count Data Ctr., Nat'l Kids Count Program, Child population by race (updated Dec. 2010), http://datacenter.kidscount.org.

REBECCA KLEIN-COLLINS, AMY SHERMAN, & LOUIS SOARES, CTR. FOR AM. PROGRESS, DEGREE COMPLETION BEYOND INSTITUTIONAL BORDERS: RESPONDING TO THE NEW REALITY OF MOBILE AND NONTRADITIONAL LEARNERS (2010).

GEORGE KUH ET AL., COMMISSIONED REPORT FOR THE NATIONAL SYMPOSIUM ON POSTSECONDARY STUDENTS: SPEARHEADING A DIALOG ON STUDENT SUCCESS 2 (2006), http:// nces.ed.gov/npec/pdf/kuh_team_report.pdf.

JOHN MICHAEL LEE JR. & TATAYA RANSOM, COLLEGEBOARD ADVOCACY & POLICY CTR., THE EDUCATIONAL EXPERIENCE OF YOUNG MEN OF COLOR: A REVIEW OF RESEARCH, PATHWAYS AND PROGRESS (2011), http://youngmenofcolor.collegeboard.org/sites/default/files/EEYMC-ResearchReport_0.pdf.

LINDSAY LOWELL & MARK REGETS, A HALF-CENTURY SNAPSHOT OF THE STEM WORKFORCE, 1950-2000 (2006), http://www.cpst.org/STEM/STEM_White1.pdf.

David Lubinski, *Spatial ability and STEM: A sleeping giant for talent identification and development*, 49 PERSONALITY & INDIVIDUAL DIFFERENCES 344 (2010).

Lindsey E. Malcom & Shirley M. Malcom, *The Double Bind: The Next Generation*, 81 HARV. EDUC. R. 162 (2011).

Tatiana Melguizo, Gregory S. Kienzl, & Mariana Alfonso, *Comparing the Educational Attainment of Community College Transfer Students and Four-Year College Rising Juniors Using Propensity Score Matching Methods*, 82 J. HIGHER EDUCATION 265 (2011).

COLLEEN MOORE, NANCY SHULOCK, & CRISTY JENSEN, INST. FOR HIGHER EDUC. LEADERSHIP & POLICY, CRAFTING A STUDENT-CENTERED TRANSFER PROCESS IN CALIFORNIA: LESSONS FROM OTHER STATES (2009).

Patrick Mulvey & Brandon Shindel, Am. Inst.of Physics Statistical Research Ctr., *Physics Bachelor's Demographic Profiles*, FOCUS ON, Aug. 2010, http://www.aip.org/statistics/trends/reports/bachdemograph10.pdf.

Laura Perna, Valerie Lundy-Wagner, Noah D. Drezner, Marybeth Gasman, Susan Yoon, Enakshi Bose, & Shannon Gary, *The Contribution of HBCUS* (sic) *to the Preparation of African American Women for STEM Careers: A Case Study*, 50 RESEARCH IN HIGHER EDUC.1 (2008).

© American Association for the Advancement of Science, 2012

Richard W. Riley, *Foreword to* ARTHUR L. COLEMAN, FRANCISCO M. NEGRÓN, JR., & KATHERINE E. LIPPER, NAT'L SCH. BDS. ASS'N, COLLEGE BD., & EDUCATIONCOUNSEL, LLC, ACHIEVING EDUCATIONAL EXCELLENCE FOR ALL: A GUIDE TO DIVERSITY-RELATED POLICY STRATEGIES FOR SCHOOL DISTRICTS 4 (2011).

Keivan G. Stassun, Arnold Burger, & Sheila E. Lange, *The Fisk-Vanderbilt Masters-to-PhD Bridge Program: A Model for Broadening Participation of Underrepresented Groups in the Physical Sciences through Effective Partnerships with Minority-Serving Institutions*, 58 J. GEOSPATIAL EDUC. 135 (2010).

TED Initiatives – TED.com, TED, http://www.ted.com/pages/initiatives_ted_com (last visited Aug. 10, 2011).

Roli Varma & Lisa M. Frehill, *Introduction to Special Issue on Science and Technology Workforce*, 53 AM. BEHAVIORAL WORKFORCE 943 (2010).

W. INTERSTATE COMM'N FOR HIGHER EDUC. & HEZEL ASSOCS., PROMISING PRACTICES IN STATEWIDE ARTICULATION AND TRANSFER SYSTEMS 5-9 (2010), http://www.hezelassociates.com/component/docman/doc_download/20-promising-practices-in-statewide-articulation-and-transfer-systems.

Donald F. Whalen & Mack C. Shelley, II, *Academic Success for STEM and Non-STEM Majors*, 11 J. STEM EDUC. 45 (2010).

WomensColleges.org, Colleges & Universities by Name, http://www.womenscolleges.org/colleges/byname (last visited Sept. 13, 2011).

Periodicals

Rachel Aviv, *Turning Life Experience into College Credit*, N.Y. TIMES (Oct. 30, 2008), http://www.nytimes.com/2008/11/02/education/edlife/strategy.html.

Daryl Chubin, *Eye on Ph.D production (Part 2): The Fisk-Vanderbilt 'Miracle,'* AAAS.ORG (June 14, 2011), http://membercentral.aaas.org/blogs/stemedu/eye-phd-production-part-2-fisk-vanderbilt-miracle.

Donna Ekal & Paula M. Krebs, *Reverse-Transfer Programs Reward Students and Colleges Alike*, CHRON. HIGHER EDUC. (June 19, 2011), http://chronicle.com/article/Reverse-Transfer-Programs/127942/.

Virginia Heffernan, *Education Needs a Digital-Age Upgrade*, N.Y. TIMES OPINIONATOR (Aug. 7, 2011, 5:30 pm), http://opinionator.blogs.nytimes.com/2011/08/07/education-needs-a-digital-age-upgrade/?ref=opinion&nl=opinion&emc=tya1.

© American Association for the Advancement of Science, 2012

Lumina Found., *El Paso colleges link up to lift students*, FOCUS, Spring 2011.

Lumina Found., *TFS shapes scientific minds*, FOCUS, Spring 2011.

John Markoff, *Virtual and Artificial, but 58.000 Want Course*, N.Y. TIMES (Aug. 15, 2011), http://www.nytimes.com/2011/08/16/science/16stanford.html?_r=1&src=me&ref=general.

Robert Margolis, *Community College Confidential,* EDUC. SECTOR (April 3, 2006), http://www.educationsector.org/print/publications/community-college-confidential.

Sabrina Tavernise*, Education Gap Grows Between Rich and Poor*, N.Y. TIMES (Feb. 9, 2012), http://www.nytimes.com/2012/02/10/education/education-gap-grows-between-rich-and-poor-studies-show.html.

Federal Government Statistics, Statutes, and Studies

20 U.S.C. § 1232g (2010).

20 U.S.C.A. § 1101a (2009).

25 U.S.C.A. § 1801 (2008).

CLIFFORD ADELMAN, U.S. DEP'T OF EDUC., MOVING INTO TOWN – AND MOVING ON: THE COMMUNITY COLLEGE IN THE LIVES OF TRADITIONAL-AGE STUDENTS (2005).

PETER EINAUDI, NAT'L CTR. FOR SCI. &ENG'G STATISTICS, TWO DECADES OF INCREASING DIVERSITY MORE THAN DOUBLED THE NUMBER OF MINORITY GRADUATE STUDENTS IN SCIENCE AND ENGINEERING, INFO BRIEF 11-319 (2011).

Tony Miller, Deputy Sec'y, U.S. Dep't of Educ., Remarks on College-Ready Students and Student-Ready Colleges, Sept. 14, 2010, https://www.ed.gov/news/speeches/college-ready-students-and-student-ready-colleges-remarks-deputy-secretary-tony-miller.

NAT'L ACADS., RISING ABOVE THE GATHERING STORM, REVISITED: RAPIDLY APPROACHING CATEGORY 5 2-3 (2010), http://www.nap.edu/catalog.php?record_id=12999.

Nat'l Sci. Found., *Low participation fields for women: Computer sciences and engineering, 1989-2008*, http://www.nsf.gov/statistics/wmpd/digest/theme2_1.cfm.

Nat'l Sci. Found., Science and Engineering Degrees by Race/Ethnicity: 1997-2006, NSF 10-300 (2008), http://www.nsf.gov/statistics/seiind08/c2/c2s4.htm#c2542.

Nat'l Sci. Found., Women, Minorities, and Persons with Disabilities in Science & Engineering, *Occupation* (Feb. 2011), http://www.nsf.gov/statistics/wmpd/digest/theme4.cfm.

© American Association for the Advancement of Science, 2012

NAT'L SCI. FOUND., NAT'L SCI. BD., SCI. AND ENG'G INDICATORS 2010, http://www.nsf.gov/statistics/seind10.

Press Office, White House, *Excerpts of the President's Remarks in Warren, Michigan and a fact sheet on the American Graduation Initiative* (July 14, 2009), http://www.whitehouse.gov/the_press_office/Excerpts-of-the-Presidents-remarks-in-Warren-Michigan-and-fact-sheet-on-the-American-Graduation-Initiative/.

President Barack Obama, Remarks by the President on the "Educate to Innovate" Campaign (Nov. 23, 2009), http://www.whitehouse.gov/the-press-office/remarks-president-education-innovate-campaign.

JOHN TSAPOGAS, INFOBRIEF: THE ROLE OF COMMUNITY COLLEGES IN THE EDUCATION OF RECENT SCIENCE AND ENGINEERING GRADUATES, NSF 04-315 , at 1, t.1 (2004).

U.S. Dep't of Educ., Nat'l Ctr. for Educ. Statistics, 2007-08 National Postsecondary Student Aid Survey: Undergraduate Students.

U.S. DEP'T OF EDUC., NAT'L CTR. FOR EDUC. STATISTICS, 2008-09 BACCALAUREATE AND BEYOND LONGITUDINAL STUDY (B&B 08/09), NCES 2011-238 (2011).

U.S. Dep't of Educ., Nat'l Ctr. for Educ. Statistics, Beginning Postsecondary Students (2009).

U.S. Dep't of Educ., Nat'l Ctr. for Educ. Statistics, *Community College Students: Goals, Academic Preparation, and Outcomes*, Postsecondary Education Descriptive Analysis Report NCES 03-164 (2003), http://nces.ed.gov/pubs2003/2003164.pdf.

U.S. Dep't of Educ., Nat'l Ctr. for Educ. Statistics, *The Condition of Education 2011* (NCES 2011-033), http://nces.ed.gov/programs/coe/indicator_pgr.asp.

U.S. Dep't of Educ., Nat'l Ctr. for Educ. Statistics, Digest of Education Statistics (2010), http://nces.ed.gov/programs/digest,

U.S. Dep't of Educ., Nat'l Ctr. for Educ. Statistics, *Digest of education statistics, 2006* (2007).

U.S. Dep't of Educ., Nat'l Ctr. for Educ. Statistics, *Fast Facts: Do you have information on postsecondary enrollment in rates?*, http://nces.ed.gov/fastfacts/display.asp?id=98 (last visited Aug. 18, 2011).

U.S. Dep't of Education, Nat'l Ctr. for Educ. Statistics, *Fast Facts: Enrollment,* http://nces.ed.gov/fastfacts/display.asp?id=98.

U.S. DEP'T OF EDUC., NAT'L CTR. FOR EDUC. STATISTICS, NONTRADITIONAL UNDERGRADUATES (2002).

© American Association for the Advancement of Science, 2012

U.S. DEP'T OF EDUC., NAT'L CTR. FOR EDUC. STATISTICS, TEN YEARS AFTER COLLEGE: COMPARING THE EMPLOYMENT EXPERIENCES OF 1992-93 BACHELOR'S DEGREE RECIPIENTS WITH ACADEMIC AND CAREER-ORIENTED MAJORS NCES 2008-155 (2008).

U.S. Dep't of Educ., White House Initiative on Historically Black Colls. &Univs., *HBCU Home*, http://www2.ed.gov/about/inits/list/whhbcu/edlite-index.html (last updated July 8, 2010).

U.S. Dep't of Educ., White House Initiative on Tribal Colls. & Univs., *Tribal Colleges & Universities List*, http://www2.ed.gov/about/inits/list/whtc/edlite-tclist.html (last updated Aug. 2, 2011).

U.S. DEP'T OF LABOR, BUREAU OF LABOR STATISTICS, FASTEST GROWING OCCUPATIONS (Dec. 8, 2010), http://www.bls.gov/emp/ep_table_103.htm.

WORKFORCE/EDUC. SUBCOMMITTEE, PRESIDENT'S COUNCIL OF ADVISORS ON SCI. AND TECH., SUSTAINING THE NATION'S INNOVATION ECOSYSTEM: REPORT ON MAINTAINING THE STRENGTH OF OUR SCIENCE & ENGINEERING CAPABILITIES 6 (2004), http://www.whitehouse.gov/sites/default/files/microsites/ostp/pcast-04-sciengcapabilities.pdf.

State/Province Policies and Statutes

ALA. CODE § 16-5-8 (2000).

AZ Transfer, AGEC Requirements: Overview (2010), http://www.aztransfer.com/AGECReqs.

British Columbia Council on Admissions and Transfer, *Principles of Articulation*, HOW TO ARTICULATE HANDBOOK (2005), http://www.bccat.bc.ca/articulation/resources/handbook/.

FLA. STAT. 1007.23 (2011).

Virginia's Community Colleges, *Guaranteed Transfer*, http://myfuture.vccs.edu/Students/Transfer/tabid/106/Default.aspx (last visited Aug. 16, 2011).

© American Association for the Advancement of Science, 2012

Appendix B: How to Perform a Course Equivalency Evaluation[172]

All course equivalency determinations should adhere to four foundational principles. The first and most important is Equivalence, the understanding that transfer courses, though not exactly the same, share key concepts and learning goals with native courses. Next are Acceptability and Applicability, the guarantee that transfer courses will be accepted in lieu of native courses and used to fulfill GE and certain major requirements. The final foundational principle is Fairness, which dictates that any restrictions on transfer courses have defensible reasons behind them and be clearly communicated to all involved parties, including institutional leadership, faculty members, and prospective students.

Course equivalency determinations often involve certain situational principles as well. Some institutions will include Reciprocity within their agreement, which allows for equivalent courses to be accepted on both ends of a transfer. That is, if institution A accepts course from institution B, then institution B should accept equivalent course from institution A. In a similar vein, some institutions will incorporate Triangulation, which allows for transfer credits to be determined with one step removed between the parties. Triangulation works like this: if course X is equivalent to course Y, and course Z is equivalent to course Y, then course X is equivalent to course Z. This situational principle is most relevant when a third institution joins a transfer agreement or when institutions determine credit awards for students who transfer more than once. The final two situational principles, Pedagogy and Delivery, involve the style of teaching for transfer courses. Pedagogy refers to the method of teaching used in transfer courses, while Delivery examines the environments in which courses were taught. These two situational principles usually apply when agreements are being formed between schools with mostly small classes and institutions with large, lecture-style classes. All of these situational principles will not apply to every agreement, but at least one is likely to come into play during collaborative agreement negotiations.

The final category of principles for course equivalence determinations are operational, which refer to attitudes and practices that can affect the success of an agreement. The first is Transparency, which means that credit decisions are made using clear assessment methods and are open to scrutiny or rebuttal. Many students become frustrated with opaque transfer credit decisions, and collaborative agreements have the potential to give students clear, predictable guidelines so that they can prepare accordingly. The second is Efficiency, which means that institutions strive to create streamlined, cost-effective systems that facilitate quick decisions on transfer applications between them. Developing automated systems and setting up guaranteed admissions policies work toward the Efficiency operational principle. Finally, institutions and their representatives should have Respect for one another's academic programs and students. The whole of the agreement process depends on institutions having esteem for one another, and trust that their collaborative counterparts will follow through on their commitments.

[172] Adapted from British Columbia Council on Admissions and Transfer, *Principles of Articulation*, HOW TO ARTICULATE HANDBOOK (2005), http://www.bccat.bc.ca/articulation/resources/handbook/.

© American Association for the Advancement of Science, 2012

Developing respect will take time, but strong relationships between institutional leadership, faculty members, and support staff are required for any collaborative agreement to succeed.

Principles for Course Equivalency Determinations[173]		
Type of Principle	**Principle**	**Description**
Foundational *Motivations behind all good transfer agreements*	Equivalence	Transfer courses, though not identical, share key concepts and learning goals.
	Acceptability	Transfer courses will be accepted in lieu of native courses.
	Applicability	Transfer courses will be used to fulfill general education and certain major requirements.
	Fairness	Restrictions on transfer courses have defensible reasons behind them and are communicated clearly to collaborating institutions and prospective students.
Situational *Considerations which are relevant but not universally applicable*	Reciprocity	If institution A accepts course from institution B, then institution B should accept equivalent course from institution A.
	Triangulation	If course X is equivalent to course Y, and course Z is equivalent to course Y, then course X is equivalent to course Z. This is most relevant when a third institution joins a transfer agreement or when institutions determine credit awards for students who transfer more than once.
	Pedagogy	Transfer courses are taught using similar methods.
	Delivery	Transfer courses were taken in similar environments.
Operational *Practices and attitudes which sometimes affect agreements*	Transparency	Transfer credit decisions are made using clear assessment methods and are open to scrutiny or rebuttal.
	Efficiency	Transfer credit decisions are made using streamlined, cost-effective systems.
	Respect	Transfer courses are given a comparable level of esteem to that shown to native courses.

[173] Adapted from British Columbia Council on Admissions and Transfer, *Principles of Articulation*, HOW TO ARTICULATE HANDBOOK (2005), http://www.bccat.bc.ca/articulation/resources/handbook/.

© American Association for the Advancement of Science, 2012

Appendix C: Template for an Institutional Collaborative Agreement

Education [and Research] Collaboration Agreement Among [Colleges and Universities]

This Agreement ("Agreement") is made as of the __ day of ___, 20___ ("Effective Date") among [Insert College and University names] (collectively "Parties" and individually, a "Party" as the context indicates) concerning their collaboration in the "Program" (defined below).

WHEREAS, [Colleges and Universities] seek to collaborate to provide educational pathways and opportunities and to facilitate transitions from one institution to others for their students in [science, technology, engineering and mathematics ("STEM")—or specify particular ones] fields; and

WHEREAS, [Colleges and Universities] believe that educational experiences and accomplishments in some of their institutions should prepare students well to progress to more advanced educational programs in other of their institutions;

Now, Therefore, in consideration of the covenants made in this Agreement and for other good and valuable consideration, the receipt and sufficiency of which are acknowledged by the Parties, the Parties hereby agree as follows:

1. DEFINITIONS

In addition to the quoted terms defined above or elsewhere in this Agreement, as used in this Agreement, the following terms, whether used in the singular or plural, shall have the following meanings:

1.1 "Commencement Date" of a Program shall mean July 1 in the calendar year in which the first students are admitted to the Program.

1.2 "Co-Director" shall mean the faculty member designated by a Party pursuant to Article 3 of this Agreement to serve as the relevant Program's Director for that Party under this Agreement and the "Co-Directors" shall mean all of the Parties' Co-Directors for the relevant Program.

1.3 "Deputy Director" shall mean each Party's Deputy Director appointed pursuant to Article 3 of this Agreement to oversee implementation of all of the Programs under this Agreement. "Deputy Directors" shall mean all of the Parties' Deputy Directors.

1.4 "Program Faculty" shall mean one of the academic staff members appointed pursuant to Article 3 of this Agreement.

© American Association for the Advancement of Science, 2012

1.5 "Joint Academic Committee" or "JAC" shall refer to the Joint Academic Committee appointed pursuant to Article 3 of this Agreement.

1.6 "Program" or "Programs" shall mean the degree-granting academic program or programs in any STEM field [or designate the particular STEM fields] at a Party that are identified by two or more Parties under this Agreement as being suitable to be linked as "Pathway Programs" providing educational pathways for students to one or more degree-granting programs at progressive educational levels, and/or to fellowships or post-doctoral appointments, at any other of the Parties, as described and defined in Article 2 of this Agreement.

2 PATHWAY PROGRAMS

2.1. Identifying Pathway Programs. The Parties agree to collaborate to review curriculum, as well as faculty and student qualifications, at their respective institutions in STEM fields [or specify specific STEM fields] and to identify a progression of related [community college, four-year undergraduate and graduate] degree-granting Programs [and post-doctoral opportunities] ("Pathway Programs"), which have curriculum requirements and educational experiences that should prepare their students well to progress from one educational level to the next and from terminal educational programs to fellowships and post-doctoral appointments, at two or more of the Parties, in the same or related STEM fields. The initial Pathway Programs, with Parties and educational levels specified, are set forth in Exhibit 1, attached to and incorporated in this Agreement. As additional Pathway Programs are identified, they will be added to Exhibit 1 by letter counter-signed by the relevant Parties, with a copy provided to the other Parties. The Parties' objective is to identify at least ____ Pathway Programs under this Agreement by the end of the first year of the "Term" (as defined in Article 5).

2.2. Admissions to Pathway Programs. The Parties will follow their own admissions standards, criteria, policies and processes in admitting, evaluating, and graduating students [or appointing graduates to post-doctoral positions]. However, the Parties agree to collaborate to review each others' curriculum, faculty, and student qualifications, quality of educational experience, and admissions, graduation [and appointment] standards, criteria, policies, and processes—and they agree to advise one another of the enhancements that would best prepare their students to advance through progressively higher educational levels in Programs at the Parties' institutions. The Parties with linked Pathway Programs will facilitate applications by their students to Programs at each succeeding level by providing counseling on educational pathways and information to raise awareness and answer questions on the process.

© American Association for the Advancement of Science, 2012

[Optional: After reviewing the curriculum, faculty and student qualifications, admissions and graduation criteria, and standards of another Party for a Program that is one in a series of Pathway Programs, the Party whose Program is the next Program in the series may, at its option, determine that: (a) a student who earns a degree in another Party's Program is automatically qualified for admission [or appointment] to its Program, which is next in the progression of linked Pathway Programs, and will be admitted [or appointed] if a completed application is timely made, space permitting; and/or (b) a student who completes an academic credit-bearing course in any of the Pathway Programs at one Party will automatically have the associated credits accepted at any other Party with a linked Pathway Program. In such event, this linkage will be noted for the relevant Pathway Programs and Parties in Exhibit 1 as well as in the relevant Parties' and Programs' degree and course catalogs [and fellowship descriptions].]

2.3. Data On Pathway Programs. Each Party shall annually during the Term collect, and by [date] report to the other Parties, data on the number of students who progress from one educational level to the next and from one Party to another in the Pathway Programs, as well as the gender, racial, and disability status of such students after the fact. The purpose is to identify Pathway Programs that are functioning well overall and are effective in increasing participation by under-served populations, as well as to identify opportunities for improvements.

During the Term, it is anticipated that the Parties should be able to provide effective pathways of educational progression for the following targeted numbers and educational attainment levels of students and that, in addition to other students, women, non-Asian minorities, and people with disabilities, who are presently not well represented in the relevant Programs at the Parties, will be increasingly represented through general and targeted outreach and barrier removal:

- ___ students earning associates' degrees in ___ at [specify Part(ies)] who progress to a four-year degree program in a STEM field at one or more other Parties (or another institution which will be documented);
- ___ students earning bachelor's degrees in __ at [specify Part(ies)] who progress to a master's degree program in a STEM field at one or more other Parties (or another institution which will be separately documented);
- ___students earning master's degrees in ___ at [specify Part(ies)] who progress to a doctoral program in a STEM field at one or more other Parties (or another institution which will be separately documented);
- ___students earning doctoral degrees in ____, who earned a lower degree at one or more of the Parties; and

© American Association for the Advancement of Science, 2012

- ___ recipients of fellowships and post-doctoral appointments at [specify Part(ies)] who earned a doctoral or lower degree at one of the Parties.

2.4 Targets General. The student graduation and educational attainment and progression targets agreed upon above in Article 2.3 are neither a minimum nor a maximum required number of students, but may be more suitably considered as feasible goals.

2.5 Outreach and Barrier Removal. The Parties agree to utilize the outreach and barrier removal approaches for recruiting students that are outlined in Exhibit 2 attached to and incorporated in this Agreement, in order to maximize the inclusiveness of the applicant pool for Pathway Programs. [Adapt Faculty Search Tool Kit, including Search Guidance and Target of Opportunity Policy, as well as any other good practices.]

2.6 Supplementary Faculty and Student Opportunities. Each Party shall identify opportunities to provide visiting, joint, adjunct, or other special temporary or part-time appointments to other Parties' faculty members in Pathway Programs, as well as summer research and supplemental educational experiences for other Parties’ students, to facilitate collaboration and opportunities for faculty and students at one institution to get to know the faculty, students, and educational opportunities of other institutions in relevant STEM fields. In so doing, each Party shall make any faculty appointments and student selections under its own standards, criteria, policies, and processes. Exhibit 3 lists summer programs currently available at each of the Parties, and shall be updated annually by each Party, which shall confirm or modify its listing by letter to the Joint Academic Committee referenced in Article 3 by December 30th of each year during the Term. Any faculty appointments and student summer program selections that are made shall be reported annually to the Joint Academic Committee by the date it specifies.

Faculty and students appointed or admitted to a Party, whether to a regular position or Program, or to a special, part-time or summer position or program, shall be subject to the appointing or admitting Party’s applicable regulations, policies and procedures for conduct, intellectual property, and other relevant matters while acting in the capacity of the appointed position or Program or program participant--or, if applicable according to the terms of the hosting Party’s regulations, policies, and/or procedures, during the period of the appointment or Program or program participation.

[2.7 *Optional—May Be Appropriate Where Automatic Qualification For Dual or Joint Admission Among Institutions Is Provided And Faculty Will Be Teaching Students of Multiple Parties--:* Joint Faculty Appointments. For all faculty and staff (excluding graduate teaching assistants) who are involved in teaching a course

© American Association for the Advancement of Science, 2012

within any of the Pathway Programs indicated as "Joint Faculty Appointment Required" in Exhibit 1, a joint, visiting or adjunct professorship appointment is required at all involved institutions where the individual does not already have a regular full-time faculty appointment. Such appointment is required before such faculty or staff may teach a course (whether through distance learning technology or live) and/or give lectures (other than a one- or few-time per semester guest lecture). These appointments shall be reviewed and made in accordance with the applicable policies, procedures, standards and criteria of the involved Parties and their relevant departments.]

3 GOVERNANCE

3.1 Joint Academic Committee

3.1.1 Authorities. The Joint Academic Committee ("JAC") shall have the following responsibilities:

a) Set the overall direction for education collaboration of the Parties, elicit information on Program linkages across Parties, and facilitate and track the review and analysis of Programs that are good candidates to be designated as Pathway Programs. Ensure that Pathway Programs, once agreed to by the relevant Parties, are duly added to Exhibit 1 as provided in Article 2.1.

b) Approve the appointment by each Party of its Programs' Co-Directors and overall Deputy Director. Provide on-going advice to the Co-Directors and Deputy Directors.

c) Review and approve key performance indicators and the form of data collection in order to provide for Parties to uniformly collect and report the data referenced in Articles 2.3 and 2.6.

d) Review the annual reports referenced in Articles 2.3 and 2.6 and advise on needed improvements and means to achieve them. Initiate and oversee management reviews, in conjunction with the Parties.

e) Review and advise on any other matters of concern to the Parties within the overall subject matter of this Agreement.

3.1.2 Appointments. The JAC shall comprise the [a Dean, the Provost, other high-ranking academic administrator] of each Party. The first Chair of the JAC shall be from [specify Party]. The Chair shall rotate every two years to another Party's representative with the out-going Chair specifying his or her successor. The Deputy Directors and Program Directors shall attend and may participate in JAC meetings, as ex officio, non-voting members.

© American Association for the Advancement of Science, 2012

3.1.3 Procedures of the JAC. The JAC and any subcommittees shall operate by majority vote and will keep written records of the actions they take, provided that: (a) each of the Parties whose Program is affected by any action must also concur in any such action with regard to that Party's Program in order for it to be effective; and (b) any action that reduces the benefit or increases the burden on or obligations of any Party under this Agreement or in connection with its Programs must also be concurred in by that Party. The JAC shall meet at least twice annually, once in ___ and once in ___, with the date specified by the Chair at least ___ months in advance. Notice to the JAC shall be by notice to the Chair serving at the time.

4 STUDENT SERVICES

4.1 General Information About Opportunities. The Deputy Director for each Party shall provide information to the Deputy Directors of all of the other Parties about the educational, fellowship and post-doctoral opportunities that the Party offers in Pathway Programs and the Deputy Directors shall distribute this information to their Parties' students in STEM fields.

4.2 Support for Students In Pathway Programs. The Program Co-Director of a Party's Pathway Program shall provide academic counseling and community building opportunities to students who enter the Program from a collaborating Party's linked Pathway Program. Each Party operating linked Pathway Programs shall provide their students with information about educational, fellowship and post-doctoral opportunities at the collaborating Parties with linked Pathway Programs.

[Add more detail as appropriate.]

5 TERM AND TERMINATION

5.1 Term. The term of this Agreement shall begin on the Effective Date and will continue in effect for five (5) years from the Commencement Date, unless extended by mutual written agreement of the Parties or terminated as provided in Article 5.2 of this Agreement (as so extended or earlier terminated, the "Term").

5.2 Termination of Agreement. Any Party may terminate this Agreement only by giving written notice to the other Parties in accordance with Article 6.4(a) on or before September 1 of any calendar year with termination to take effect on July 1 of the following calendar year.

5.3 Survival of Terms. In addition to such provisions which survive the termination of this Agreement in accordance with their terms, or by operation of law, the provisions of Articles ________shall continue in force in accordance with their terms, notwithstanding the termination of this Agreement for any reason.

© American Association for the Advancement of Science, 2012

5.4 Termination of Pathway Programs. Programs that are components of linked Pathway Programs designated by Parties under this Agreement may be terminated by the Party operating the Program at that Party's sole discretion. As soon as practicable before any such termination, or promptly upon termination at the latest, the terminating Party shall notify all other Parties and the JAC, whereupon Exhibit 1 will be correspondingly updated.

6 ADMINISTRATIVE

6.1 Use of Names. This Agreement does not grant any trademark, service mark, or other right to any Party in any other Party's name, trademarks, or service marks. None of the Parties may use the name, trademark, or service marks of any other Party for any purpose, whether in relation to any advertisement, or other form of publicity, fundraising, or for any other purpose without obtaining the prior written consent of the appropriate Party in the case of [name a College or University], that of the Director of its News Office, in the case of [name another College or University], that of its ____Office, and [etc., etc.]. The Deputy Directors shall liaise among the Parties in connection with the aforementioned approval process.

6.2 Publicity. Upon the execution of this Agreement, the Parties may issue a mutually agreed upon press release announcing the Agreement and its purpose. Any publicity or media materials about this Agreement or the activities of the Parties under it shall be mutually agreed upon by the Parties prior to release. Where only some Parties are involved in the announcement of Pathway Programs, and only those Parties are to be mentioned, only those Parties need agree on the description of the particular Pathway Programs and their collaboration in those Programs.

Notwithstanding the generality of the preceding sub-clause of this Article 6.2 and of Article 6.1, a Party may notify third parties of the fact that this Agreement is in effect to increase educational pathways in STEM fields for students at the Parties, and may identify the Parties.

It is acknowledged that public institutions that are Parties to this Agreement may be required by law to provide a copy or information about this Agreement to members of the public or government authorities.

6.3 No Assignment. This Agreement shall benefit the Parties hereto. Neither this Agreement, nor any rights hereunder, may be assigned directly or indirectly by any Party without first receiving the written consent of the other Parties. Any attempted assignment made without such consent shall be void. Without derogating from the foregoing, this Agreement shall be binding upon and benefit the Parties hereto and their

© American Association for the Advancement of Science, 2012

consented to successors and assigns, and shall be binding upon any non-consented-to successor or assign.

6.4 Miscellaneous Provisions.

(a) Notices. Except as otherwise specifically provided in this Agreement, all notices, requests, consents, approvals, appointments, designations and reports under this Agreement shall be effective only if given or made in writing or by telecopier or email, with all delivery charges prepaid, addressed to a Party to the attention of the offices or individual(s) and at the address or to the telecopier number or email address specified for that Party in this clause (a) and to such additional or other addressees, addresses, telecopier numbers, and/or email addresses as any Party may designate by notice to the other Parties in accordance with this clause, and shall be effective at the times, and only if given by the means, specified below:

-- By telecopier, effective upon receipt by the intended recipient, as evidenced by a confirmation of receipt generated by the transmitting telecopier;
-- By nationally recognized commercial courier service or by government certified or registered mail return receipt requested, effective upon delivery or refusal of delivery by or on behalf of the intended recipient, as evidenced by the delivery receipt;
-- By hand delivery using a commercial courier service, effective upon delivery or refusal of delivery by or on behalf of the intended recipient, as evidenced by the delivery receipt, or by other hand delivery effective upon delivery or refusal of delivery by or on behalf of the intended recipient according to all relevant evidence; or
-- By email, effective upon receipt, as evidenced by the sending email account, without any failure of delivery.

The addressees, addresses, telecopier numbers, and email addresses for notice shall be:

[INSERT ONE FOR EACH PARTY]:
Party: ____
In care of Name and Title: __________________________
Address: ____
Telecopier Number: _______________________________
Email Address: ____________________________________

The Parties will provide to each other by email or telecopier the email addresses of their other representatives, if any, who are to receive notices, reports, requests, or other information under specific provisions of this Agreement.

(b) No Third Party Beneficiary: There are absolutely no third party beneficiaries of this agreement.

© American Association for the Advancement of Science, 2012

(c) No Waiver/Severability/Captions. No waiver of any provision or breach of this Agreement shall be effective unless the waiver is expressly made in writing by the waiving Party. A waiver on one occasion or of one provision or breach shall not constitute a waiver on any other occasion or of another provision or breach. The provisions of this Agreement are severable, and if any provision, or any portion thereof, is determined by a court or arbitrator of competent jurisdiction, or by legislative or administrative agency action, to be invalid, illegal, or unenforceable for any reason, any remaining portions of that provision, and all other provisions of this Agreement, shall remain valid and enforceable to the fullest extent permitted by law and equity in order to give effect to the Parties' intentions under this Agreement. The captions used in the Agreement are for convenience only and shall not be deemed to have any relevance to the meaning of any provisions.

(d) No Special Consequential Damages. IN NO EVENT SHALL ANY OF THE PARTIES, OR THEIR RESPECTIVE TRUSTEES, MEMBERS, DIRECTORS, OFFICERS, EMPLOYEES, AGENTS, STUDENTS, AND/OR AFFILIATES BE LIABLE FOR INCIDENTAL, CONSEQUENTIAL, EXEMPLARY, PUNITIVE, TREBLE, SPECIAL, OR OTHER INDIRECT DAMAGES OR LOST PROFITS OF ANY KIND, ARISING OUT OF ANY ACT OR OMISSION UNDER THIS AGREEMENT OR IN CONNECTION WITH THE ANY PATHWAY PROGRAM, INCLUDING WITHOUT LIMITATION, ECONOMIC DAMAGES, REGARDLESS OF WHETHER OR NOT A PARTY SHALL BE ADVISED, SHALL HAVE OTHER REASON TO KNOW, OR IN FACT SHALL KNOW, OF THE POSSIBILITY OF THE FOREGOING.

THIS CLAUSE (d) SHALL SURVIVE THE EXPIRATION OR TERMINATION OF THIS AGREEMENT.

(e) No Partnership/Joint Venture. The relationship of the Parties under this Agreement is that of independent contractors and they are not agents, employees, partners or joint venturers of one another. No Party has the authority to bind the other Party in contract or to incur any debts or obligations on behalf of the other Party, and no Party (including but not limited to the Co-Directors, Deputy Directors, or any employee or other representative of a Party with responsibility for Programs) shall take any action that attempts or purports to bind the other Party in contract or to incur any debts or obligations on behalf of the other Party, without the affected Party's prior written approval. [Include when Parties' names are part of the Program name or as warranted: Any contract entered into by one Party to this Agreement for goods, services or other matters relating to the Pathway Programs shall include a provision under which the contracting parties acknowledge that the other Party to this Agreement has no liability or obligation under the contract.] [Name A Party]'s Director and Co-Director at [Party] does not have authority to bind [Party] or the other Party in contract; all contracts entered into under this Agreement by [Party] shall be executed by [Party's insert title] or another authorized officer of [Party]. [Repeat for each Party.] Nothing in this Agreement confers a right on the any Party to use and occupy space at any other Party.

(f) Entire Agreement/Amendments. This Agreement represents the entire agreement of the Parties concerning the subject matter addressed, and supersedes any contemporaneous and previous negotiations, drafts, and agreements between the Parties, whether oral, in

© American Association for the Advancement of Science, 2012

writing, electronic, or in any other medium concerning the same, including without limitation any term sheet or drafts of the Agreement [except only—specify]. The Agreement may be amended only by a written agreement signed and delivered by authorized representatives of all Parties (or the affected Parties under Article 2.1).

(g) Governing Law. This Agreement shall be governed by, construed and enforced for all purposes in accordance with the laws of the State of _____, without regard to such laws governing choice of law. [If public institutions are involved, it may be necessary to be silent on choice of law if the public institution's law is not to be specified.]

(h) Dispute Resolution and Arbitration. Any disputes between the Parties in connection with or arising out of this Agreement shall first be resolved by the Parties involved in the dispute by their respective [Insert Provost or other senior official]. If such discussions fail to resolve the matter within 90 days of a Party requesting of one or more other Parties that they initiate discussions, the matter shall be resolved by arbitration to be conducted in [insert convenient neutral locale] in accordance with the Commercial Arbitration Rules of the American Arbitration Association, as then in effect, which rules are deemed to be incorporated in this clause by this reference. Each involved Party shall select an arbitrator and the Parties' selected arbitrators shall select the arbitrator who shall decide the dispute. All of the arbitrators shall have at least 15 years of experience arbitrating or adjudicating the relevant type of dispute and claim. Provided that each arbitrator satisfies such experience, the arbitrators need not be resident or professionally credentialed in the locale of where the arbitration is conducted. The determination of the deciding arbitrator shall be final and binding on the Parties to this Agreement, and may be enforced in any court of competent jurisdiction, and each Party consents to jurisdiction and venue for that purpose. Each Party involved in the dispute shall pay the costs of the arbitrator it appoints and shall share equally the costs of the deciding arbitrator and all other arbitration costs.

(i) Each Party represents and warrants to the other Parties that, to the best of the Party's knowledge, in all material respects: (i) the Party is duly organized and validly existing under the laws of the jurisdiction in which it is organized; (ii) the Party has all requisite corporate capacity, has taken all requisite corporate action, and has obtained all governmental authority and permission that are necessary, if any, to enter into and perform the Party's obligations under this Agreement; (iii) the individual signing this Agreement on behalf of the Party is the incumbent of the office that is duly authorized to execute and deliver the Agreement on behalf of the Party; (iv) this Agreement represents the duly authorized, binding, and valid obligation of the Party, and is enforceable against the Party in accordance with its terms; (v) the Party's entering into and performing this Agreement, subject to and in accordance with its terms, will not violate any contract, law, regulation or other governmental requirement to which the Party is subject; and (vi) the Party did not rely on any representation or warranty by or on behalf of the other Party in entering into this Agreement, other than what is stated or incorporated in this Agreement.

© American Association for the Advancement of Science, 2012

The Parties hereby execute this Agreement as of the Effective Date, by their duly authorized representatives, in multiple counterparts, each of which when all counterparts are executed and delivered shall constitute a single binding agreement.

[Add signature lines.]

© American Association for the Advancement of Science, 2012

Appendix D: Overview and Sample Language for a Recruitment Consortium

________, is hosting an electronic Recruitment Consortium on Facebook and a Consortium website to increase participation of under-served populations in science, technology, engineering, and mathematics (STEM) fields (including women, non-Asian minorities, people with disabilities) and others in STEM graduate programs and academic and industrial careers.

Colleges, universities, STEM-research supporting government agencies, and corporations desiring to participate in the recruitment consortium will be asked to sign a consortium agreement and pay a one-time $1,500 fee, and a smaller annual renewal fee, to help cover costs of building and supporting the Consortium sites. Each institution will then receive an institutional pass-code for access to the Consortium website.

Focus groups will be established within the Consortium based on field and transition point in the STEM pipeline (e.g., community college to undergraduate program in a field, undergraduate to graduate program in a field, graduate program to academic fellowship in a field, graduate program or fellowship to industry position in a field, or doctoral degree or fellowship to tenure-track faculty position in a field). Within any focus group, participating colleges and universities will invite their students, recent doctoral recipients, and post-doctoral fellows/associates to enter their information on the Consortium Facebook page (name, degrees earned, current program/institution, field, faculty mentor and references, research subjects, publications, honors, and contact information by email and text), which will link to the Consortium website. Registering individuals will have the option of designating themselves as from an under-served group. Each institution will be responsible for providing individual pass-codes to the Facebook page for their registered students, recent graduates, and post-doctoral fellows/associates who want to sign up.

All students, recent graduates, and post-doctoral fellows/associates in relevant disciplines will have the opportunity to register in the database. Participating colleges, universities, government agencies, and corporations that seek to recruit students, post-doctoral fellows/associates, or junior faculty and research staff will be able to search the Consortium Web site database for any interested and qualified individuals. Institutions, including individuals of under-served groups, also will be able to send emails and text messages to particular or categories of students, recent graduates and fellows through the Consortium website. The optional racial and gender designations will not be produced to the participating institutions but institutions will be able to target emails to such groups to encourage applications. ***When a participating institution uses the recruitment consortium for a particular recruitment, it does so for general as well as for targeted outreach—and it may also undertake other general and targeted outreach.*** For example, a general email is sent to all students of a relevant discipline and educational level who have registered, and some targeted contact is also made to registrants of under-served groups to foster a broadly inclusive applicant pool.

© American Association for the Advancement of Science, 2012

Affinity groups of like institutions and complementary institutions may be formed within the Consortium (e.g., research 1 institutions and complementary Historically Black Colleges and Universities or other institutions with high women and minority enrollments—community colleges and four-year colleges and universities, etc.). (Colleges and universities in the Consortium will also be asked to input data on their women and under-represented minority enrollment and graduation rates per field for undergraduates and graduate students.) A Consortium governing board of provosts within the participating colleges and universities will meet at least twice annually to consider the effectiveness and possible enhancements to the Consortium, as well as to indentify top producers of degrees earned by women and under-represented minorities to assist institutions in identifying such institutions as affinity group partners. Members of affinity groups will be able to send messages to their group members when seeking to recruit undergraduates to graduate programs or graduate students to fellowships and post-doctoral programs, or graduates or post-doctoral fellows to junior faculty positions, etc.

© American Association for the Advancement of Science, 2012

Appendix E: Directory of Historically Black Colleges and Universities, Hispanic-Serving Institutions, Tribal Colleges and Universities, and All-Women's Colleges

Historically Black Colleges and Universities[174]

ALABAMA
Alabama A&M University
Alabama State University
Bishop State Community College
Concordia College Selma
Gadsden State Community College, Valley Street
J.F. Drake State Technical College
Lawson State Community College
Miles College
Oakwood College
Selma University
Shelton State Community College
Stillman College
Talladega College
Trenholm State Technical College
Tuskegee University

ARKANSAS
Arkansas Baptist College
Philander Smith College
Shorter College
University of Arkansas at Pine Bluff

DELAWARE
Delaware State University

DISTRICT OF COLUMBIA
Howard University
University of the District of Columbia

FLORIDA
Bethune-Cookman University
Edward Waters College
Florida A&M University
Florida Memorial University

GEORGIA
Albany State University
Clark Atlanta University
Fort Valley State University
Interdenominational Theological Center
Morehouse College
Morehouse School of Medicine

[174] White House Initiative on Historically Black Colls. & Univs., U.S. Dep't of Educ., List of Accredited HBCUs, http://www2.ed.gov/about/inits/list/whhbcu/accredited-hbcus.xls (last updated July 8, 2010).

© American Association for the Advancement of Science, 2012

Morris Brown College
Paine College
Savannah State University
Spelman College

KENTUCKY
Kentucky State University

LOUISIANA
Dillard University
Grambling State University
Southern University A&M College
Southern University at New Orleans
Southern University at Shreveport
Xavier University of Louisiana

MARYLAND
Bowie State University
Coppin State University
Morgan State University
University of Maryland, Eastern Shore

MICHIGAN
Lewis College of Business

MISSISSIPPI
Alcorn State University
Coahoma Community College
Hinds Community College, Utica
Jackson State University
Mississippi Valley State University
Rust College
Tougaloo College

MISSOURI
Harris-Stowe State University
Lincoln University of Missouri

NORTH CAROLINA
Barber-Scotia College
Bennett College
Elizabeth City State University
Fayetteville State University
Johnson C. Smith University
Livingstone College
North Carolina A&T State University
North Carolina Central University
St. Augustine's College
Shaw University
Winston Salem State University

OHIO

© American Association for the Advancement of Science, 2012

Central State University
Wilberforce University

OKLAHOMA
Langston University

PENNSYLVANIA
Cheyney University of Pennsylvania
Lincoln University

SOUTH CAROLINA
Allen University
Benedict College
Claflin University
Clinton Junior College
Denmark Technical College
Morris College
South Carolina State University
Voorhees College

TENNESSEE
Fisk University
Knoxville College
Lane College
LeMoyne-Owen College
Meharry Medical College
Tennessee State University

TEXAS
Huston-Tillotson University
Jarvis Christian College
Paul Quinn College
Prairie View A&M University
Southwestern Christian College
St. Philip's College
Texas College
Texas Southern University
Wiley College

VIRGINIA
Hampton University
Norfolk State University
Saint Paul's College
Virginia State University
Virginia Union University
Virginia University of Lynchburg

WEST VIRGINIA
Bluefield State College
West Virginia State University

U.S. VIRGIN ISLANDS

© American Association for the Advancement of Science, 2012

University of the Virgin Islands

© American Association for the Advancement of Science, 2012

Hispanic-Serving Institutions[175]

ARIZONA
Arizona Western College
Central Arizona College
Cochise College
Estrella Mountain Community College
GateWay Community College
Phoenix College
Pima Community College
South Mountain Community College

CALIFORNIA
Allan Hancock College
Alliant International University
Bakersfield College
Cabrillo College
California Christian College
California State Polytechnic University- Pomona
California State University- Bakersfield
California State University- Channel Islands
California State University- Dominguez Hills
California State University- Fresno
California State University- Fullerton
California State University- Long Beach
California State University- Los Angeles
California State University- Monterey Bay
California State University- Northridge
California State University- San Bernardino
California State University- San Marcos
California State University- Stanislaus
Canada College
Casa Loma College- Van Nuys
Cerritos College
Chabot College
Chaffey College
Citrus College
College of the Canyons
College of the Desert
Community Christian College
Contra Costa College
Crafton Hills College
Cypress College
East Los Angeles College
East San Gabriel Valley Regional Occupational Program
El Camino College- Compton Center
El Camino Community College District
Evergreen Valley College
Fresno City College
Fresno Pacific University
Gavilan College

[175] EXCELENCIA IN EDUCATION, LIST OF 2009-10 HSIS (2011), http://edexcelencia.org/system/files/hsilist-2009-10.pdf

© American Association for the Advancement of Science, 2012

Hartnell College
Humphreys College- Stockton and Modesto Campuses
Imperial Valley College
Interamerican College
La Sierra University
Long Beach City College
Los Angeles City College
Los Angeles County College of Nursing and Allied Health
Los Angeles Harbor College
Los Angeles Mission College
Los Angeles ORT College
Los Angeles ORT College- Van Nuys
Los Angeles Pierce College
Los Angeles Trade Technical College
Los Angeles Valley College
Los Medanos College
Merced College
Modesto Junior College
Monterey Institute of International Studies
Mount St. Mary's College
Mt. San Antonio College
Mt. San Jacinto Community College District
Notre Dame de Namur University
Oxnard College
Pacific Oaks College
Palo Verde College
Palomar College
Pasadena City College
Porterville College
Reedley College
Rio Hondo College
Riverside Community College
San Bernardino Valley College
San Diego City College
San Diego State University- Imperial Valley Campus
San Joaquin Delta College
San Jose City College
Santa Ana College
Santa Monica College
Santiago Canyon College
Southwestern College
Taft College
The National Hispanic University
University of California- Merced
University of California- Riverside
University of La Verne
Ventura College
West Hills College- Coalinga
West Hills College- Lemoore
West Los Angeles College
Whittier College
Woodbury University

© American Association for the Advancement of Science, 2012

COLORADO
Adams State College
Colorado Heights University
Colorado State University- Pueblo
Otero Junior College
Pueblo Community College
Trinidad State Junior College

CONNECTICUT
Capital Community College

FLORIDA
Barry University
Broward College
Carlos Albizu University- Miami Campus
City College-Casselberry
City College-Miami
Florida International University
Hodges University
Jones College- Miami Campus
Miami Dade College
Nova Southeastern University
Polytechnic University of Puerto Rico- Miami Campus
Saint John Vianney College Seminary
Saint Thomas University
Trinity International University
Universidad Politecnica de Puerto Rico- Orlando Campus
University of Miami
Valencia Community College

GEORGIA
Southern Catholic College

ILLINOIS
City Colleges of Chicago- Harold Washington
College
City Colleges of Chicago- Harry S Truman College
City Colleges of Chicago- Malcolm X College
City Colleges of Chicago- Richard J Daley College
City Colleges of Chicago- Wilbur Wright College
Dominican University
Elgin Community College
Lexington College
Morton College
Northeastern Illinois University
Saint Augustine College
Triton College
Waubonsee Community College

INDIANA
Calumet College of Saint Joseph

© American Association for the Advancement of Science, 2012

KANSAS
Dodge City Community College
Donnelly College
Garden City Community College
Seward County Community College and Area Technical School

MARYLAND
St. Mary's Seminary & University

MASSACHUSETTS
Northern Essex Community College
Urban College of Boston

NEW JERSEY
Bergen Community College
Hudson County Community College
New Jersey City University
Passaic County Community College
Saint Peter's College

NEW MEXICO
Central New Mexico Community College
Clovis Community College
Eastern New Mexico University- Main Campus
Eastern New Mexico University- Roswell Campus
Eastern New Mexico University- Ruidoso
Luna Community College
Mesalands Community College
New Mexico Highlands University
New Mexico Institute of Mining and Technology
New Mexico Junior College
New Mexico Military Institute
New Mexico State University- Alamogordo
New Mexico State University- Carlsbad
New Mexico State University- Dona Ana
New Mexico State University- Grants
New Mexico State University- Main Campus
Northern New Mexico College
Santa Fe Community College
University of New Mexico- Los Alamos Campus
University of New Mexico- Main Campus
University of New Mexico- Taos Branch
University of New Mexico- Valencia County Branch
University of the Southwest
Western New Mexico University

NEW YORK
Boricua College
College of Mount Saint Vincent
CUNY Borough of Manhattan Community College

© American Association for the Advancement of Science, 2012

CUNY Bronx Community College
CUNY City College
CUNY Hostos Community College
CUNY John Jay College Criminal Justice
CUNY LaGuardia Community College
CUNY Lehman College
CUNY New York City College of Technology
CUNY Queensborough Community College
Mercy College
Professional Business College
Vaughn College of Aeronautics and Technology

OREGON
Mount Angel Seminary

PUERTO RICO
American University of Puerto Rico-Bayamon
American University of Puerto Rico-Manati
Atenas College
Atlantic College
Bayamon Central University
Caribbean University- Bayamon
Caribbean University- Carolina
Caribbean University- Ponce
Caribbean University- Vega Baja
Carlos Albizu University
Centro de Estudios Multidisciplinarios-San Juan
Centro de Estudios Multidisciplinarios-Humacao
Centro de Estudios Multidisciplinarios-Bayamon
Colegio Pentecoastal Mizpa
Colegio Universitario de San Juan
EDP College of Puerto Rico Inc- San Sebastian
Escuela de Artes Plasticas de Puerto Rico
Humacao Community College
Instituto Tecnologico de Puerto Rico- Guayama Instituto Tecnologico de Puerto Rico- Recinto de Ponce
Instituto Tecnologico de Puerto Rico- Recinto de San Juan
Inter American University of Puerto Rico- Aguadilla
Inter American University of Puerto Rico- Arecibo Inter American University of Puerto Rico- Barranquitas
Inter American University of Puerto Rico- Bayamon
Inter American University of Puerto Rico- Fajardo
Inter American University of Puerto Rico- Guayama
Inter American University of Puerto Rico- Metro
Inter American University of Puerto Rico- Ponce Inter American University of Puerto Rico- San German
John Dewey College
John Dewey College- University Division
Pontifical Catholic University of Puerto Rico- Arecibo
Pontifical Catholic University of Puerto Rico-Mayaguez
Pontifical Catholic University of Puerto Rico- Ponce
Puerto Rico Conservatory of Music
Universal Technology College of Puerto Rico
Universidad Adventista de las Antillas
Universidad Central Del Caribe

© American Association for the Advancement of Science, 2012

Universidad Del Este
Universidad Del Turabo
Universidad Metropolitana
Universidad Politecnica de Puerto Rico
Universidad Teologica del Caribe
University of Puerto Rico at Cayey
University of Puerto Rico in Ponce
University of Puerto Rico- Aguadilla
University of Puerto Rico- Arecibo
University of Puerto Rico- Bayamon
University of Puerto Rico- Carolina
University of Puerto Rico- Humacao
University of Puerto Rico- Mayaguez
University of Puerto Rico- Medical Sciences Campus
University of Puerto Rico- Rio Piedras Campus
University of Puerto Rico- Utuado
University of Sacred Heart

TEXAS
Amarillo College
Angelo State University
Austin Graduate School of Theology
Baptist University of the Americas
Brazosport College
Brookhaven College
Coastal Bend College
College of Biblical Studies- Houston
Del Mar College
Eastfield College
El Centro College
El Paso Community College
Frank Phillips College
Galveston College
Houston Baptist University
Houston Community College
Howard College
Laredo Community College
Lee College
Midland College
Mountain View College
North Lake College
Northwest Vista College
Odessa College
Our Lady of the Lake University- San Antonio
Palo Alto College
Saint Edward's University
San Antonio College
San Jacinto Community College
South Plains College
South Texas College
Southwest Collegiate Institute for the Deaf
Southwest Texas Junior College

© American Association for the Advancement of Science, 2012

Southwestern Adventist University
St. Marys University
St. Philips College
Sul Ross State University
Texas A&M International University
Texas A&M University- Corpus Christi
Texas A&M University- Kingsville
Texas State Technical College Harlingen
The University of Texas at Brownsville
The University of Texas at El Paso
The University of Texas at San Antonio
The University of Texas Health Science Center at San Antonio
The University of Texas of the Permian Basin
The University of Texas- Pan American
University of Houston- Downtown
University of St. Thomas
University of the Incarnate Word
Victoria College
Western Texas College
Wharton County Junior College

WASHINGTON
Big Bend Community College
Heritage University
Yakima Valley Community College

© American Association for the Advancement of Science, 2012

Tribal Colleges and Universities[176]

ALASKA
Ilisagvik College

ARIZONA
Dine College
Tohono O'odham Community College

KANSAS
Haskell Indian Nations University

MICHIGAN
Bay Mills Community College
Keweenaw Bay Ojibwa Community College
Saginaw Chippewa Tribal College

MINNESOTA
Fond du Lac Tribal and Community College
Leech Lake Tribal College
White Earth Tribal and Community College

MONTANA
Blackfeet Community College
Chief Dull Knife College
Fort Belknap College
Fort Peck Community College
Little Big Horn College
Salish Kootenai College
Stone Child College

NEBRASKA
Nebraska Indian Community College
Little Priest Tribal College

NEW MEXICO
Navajo Technical College
Institute of American Indian Arts
Southwestern Indian Polytechnic Institute

NORTH DAKOTA
Cankdeska Cikana (Little Hoop) Community College
Fort Berthold Community College
Sitting Bull College
Turtle Mountain Community College
United Tribes Technical College

OKLAHOMA
College of Muscogee Nation

[176] White House Initiative on Tribal Colls. & Univs., U.S. Dep't of Educ., Tribal Colleges & Universities Address List, http://www2.ed.gov/about/inits/list/whtc/edlite-tclist.html (last updated Aug. 2, 2011).

Comanche Nation College

SOUTH DAKOTA
Oglala Lakota College
Sinte Gleska University
Sisseton Wahpeton College

WASHINGTON
College of Menominee Nation
Lac Courte Oreilles Ojibwa Community College

WYOMING
Wind River Tribal College

All Women's Colleges[177]

ALABAMA
Judson College

CALIFORNIA
Mills College
Mount St. Mary's College
Scripps College

COLORADO
The Women's College of the University of Denver

CONNECTICUT
Saint Joseph College

DISTRICT OF COLUMBIA
Trinity Washington University

GEORGIA
Agnes Scott College
Brenau University
Spelman College
Wesleyan College

INDIANA
Saint Mary-of-the-Woods College
Saint Mary's College

KENTUCKY
Midway College

LOUISIANA
Newcomb College Institute of Tulane University

MARYLAND
College of Notre Dame of Maryland

MASSACHUSETTS
Bay Path College
Mount Holyoke College
Pine Manor College
Simmons College
Smith College
Wellesley College

MINNESOTA
College of Saint Benedict
St. Catherine University

[177] WomensColleges.org, Colleges & Universities by Name, http://www.womenscolleges.org/colleges/byname (last visited Sept. 13, 2011).

MISSOURI
Cottey College
Stephens College

NEBRASKA
College of Saint Mary

NEW JERSEY
College of Saint Elizabeth
Douglass Residential College of Rutgers University
Georgian Court University

NEW YORK
Barnard College
Russell Sage College of The Sage Colleges
The College of New Rochelle

NORTH CAROLINA
Bennett College for Women
Meredith College
Peace College
Salem College

OHIO
Ursuline College

PENNSYLVANIA
Bryn Mawr College
Carlow University
Cedar Crest College
Chatham University
Moore College of Art and Design
Wilson College

SOUTH CAROLINA
Columbia College
Converse College

TEXAS
Texas Woman's University

VIRGINIA
Hollins University
Mary Baldwin College
Sweet Briar College

WISCONSIN
Alverno College
Mount Mary College