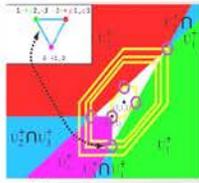


BROADENING PARTICIPATION

in the US and UK

KEYS TO GROWING UNDERREPRESENTED STUDENT POPULATIONS

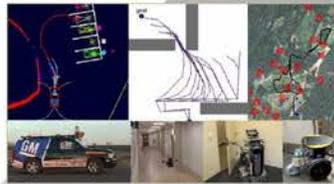
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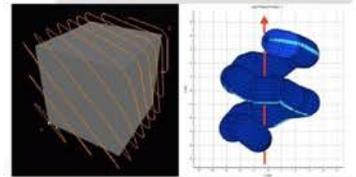
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STEM
WORKFORCE

“To ensure the long-term prosperity of our Nation, we must renew our collective commitment to excellence in education and the development of scientific talent.

Currently, far too many of America’s best and brightest young men and women go unrecognized and underdeveloped, and, thus, fail to reach their full potential.

This represents a loss for both the individual and society.”

US National Science Board

Broadening Participation in the US and UK
Keys to Growing Underrepresented Student Populations in STEM
RI Technical Report TR-13-17

* * *

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April 2013

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EXECUTIVE SUMMARY

Carnegie Mellon University (CMU) and the University of the West of England (UWE) formed a Prime Minister's Initiative grant award (PMI2) team to undertake a year-long exploration of common challenges, promising practices, and keys to growing the underrepresented student populations in *science, technology, engineering and mathematics* (STEM) fields in the United States and the United Kingdom. The aim of the collaboration was to characterize, compare, and contrast US and UK approaches that were designed to achieve broad participation in university-level STEM education. From this collaboration, each university partner would be free to develop and apply future programmatic methodology to its student populations based on demographic, university and policy context. Although Carnegie Mellon University and the University of the West of England both function in the higher education arena, interest areas for information gathering in this project differed for each partner. For this investigation, the CMU focus was the advancement to graduate education of underrepresented undergraduate student populations in STEM disciplines to graduate education. On the education continuum from secondary school through higher education (i.e. undergraduate, graduate and terminal degree), UWE expressed particular concern with the progression of students from low social economic backgrounds and Black and Minority Ethnic (BME) groups from secondary school to higher education (HE) in STEM fields.

Science, technology, engineering and mathematics (STEM) are recognized as critical drivers of economic growth in developed nations. STEM and its applications are vital to the prosperity of both the US and UK. In both nations, patterns of aging, retirement, immigration, and demographic growth are altering the composition of the STEM labor force. The US and UK face critical STEM domestic skills gaps and intensifying global competition for STEM talent. Left unaddressed, this has the potential to wreak havoc on US and UK competitiveness and living standards. Broadening/ widening participation (BP/WP) of underrepresented groups in STEM fields are national imperatives.

For the PMI2 CMU-UWE team, this experience brought to light successful US and UK university promising practices of broadening / widening participation¹. The promising practices identified in this collaboration address issues from the entire student lifecycle (i.e. student engagement, education, recruitment, retention, employability, progression to graduate studies, and career success). These practices were collected from a cross-section of higher education institutions representing a range of Carnegie Classifications (i.e. size, setting, research activity), not-for-profit organizations, and national advocacy networks (Carnegie Foundation). Student populations ranged from predominantly white to majority students of color.

Of special interest was team learning visits to Historically Black Colleges and Universities (HBCUs) and discussion of potential US-UK-HBCU partnerships. HBCU leadership holds unique expertise on effective practices that support the entire lifecycle of minority students, from transition to college life through engagement, education, recruitment, retention, employability graduate studies to professional life. During their decades-long course of support of minority education and advancement, HBCUs have incorporated into their campus cultures and alumni relations, effective lifelines for STEM student success and progression. The HBCUs that were visited, offered this experience for further investigation, as a cornerstone to build inclusive academic communities.

Both the US and UK governments and industrial sectors have invested heavily in STEM education and workforce development. Universities also have a special role to play to ensure that all students have access to rigorous STEM education and the opportunity to experience the thrill of scientific discovery. The US and UK are facing related issues and policy agendas. The similarities and differences that emerge from each nation's social and political histories enrich the conversation and the learning opportunities. *It remains clear that US and UK universities are natural partners in education, research, and industry.*

¹ This report shares the collective experience of the CMU PMI2 team members and outlines the promising practices explored during the two part US learning visit. More information about the UK learning visit may be obtained by contacting the University of the West of England's Schools and Colleges Partnership Services.

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Technology: http://www.ri.cmu.edu/research_guide/field_robotics.html

Engineering: http://www.ri.cmu.edu/research_guide/planning_scheduling.html

Mathematics: http://www.ri.cmu.edu/research_project_detail.html?project_id=403&menu_id=261
http://www.ri.cmu.edu/research_project_detail.html?project_id=735&menu_id=261

Part I: Carnegie Mellon University and University of the West of England

Carnegie Mellon University's picture: MS-RT PP2

Part II: Exploration

http://all-free-download.com/free-vector/vector-clip-art/mars_global_surveyor_clip_art_20182.html

Part III: Learning visit

http://all-free-download.com/free-vector/vector-misc/business_presentation_119655.html

INTRODUCTION

Science, technology, engineering, and mathematics (STEM) and its applications are recognized as critical drivers of economic growth in today’s globalized world. STEM offers developing nations new paths to prosperity through efficiency gains and competitive advantages from STEM innovations. Growing the STEM workforce by increasing the participation of underrepresented groups in STEM fields has emerged as a strategic national policy in both the US and UK. However, the US and UK continue to face potentially crippling STEM domestic skills gaps and intensifying global competition for STEM talent (CBI, 2011).

Carnegie Mellon University (CMU) and the University of the West of England (UWE) undertook a year-long exploration of promising practices, common barriers, and keys to growing the underrepresented student populations in STEM fields. As providers of a highly skilled, multi-faceted, STEM-trained work force, universities play a key role in creating a sustainable economy. In comparing and contrasting aspects for this shared priority, similarities and differences emerged, but, the institutional challenge appeared to be same: **how does a university identify and implement the most successful methods of attracting, retaining, inspiring, and graduating students from groups underrepresented in STEM fields?**

TABLE 1: 2008 Representation in STEM, by race/ethnicity: minorities are underrepresented

	WHITE	AFRICAN-AMERICAN	LATINO	ASIAN	OTHER
Proportions of workers in STEM occupations by race (%)	71	6	6	16	2
Proportions of workers in all occupations by race (%)	65	12	16	5	2

Source: Georgetown Center on Education and the Workforce, STEM

The approaches and language used to describe efforts to increase participation of underrepresented groups in STEM fields are informed by the unique social and political histories of each country. The preferred US term, *broadening participation (BP)*, refers to policies, activities, and efforts to increase participation of African Americans, Hispanics, Native Americans, women, and students with disabilities. The US National Science Foundation (NSF) also includes categories of institutions and geographic areas that participate at a comparatively lower rate in NSF programming in its broadening participation strategy (NSF Broadening Participation Working Group, 2008). There is limited discussion of low social economic backgrounds and more of an emphasis on ethnicity in US broadening participation policies and programming. *Widening participation (WP)*, the term used in the UK and Europe, aims to raise participation and success in higher education by students from low social economic backgrounds, ethnic minorities, women, and students with disabilities (Teaching and Learning Research Programme, 2008). The Higher Education Funding Council for England (HEFCE) declares that widening participation in action means “social background does not inhibit access to, and success within, HE [higher education]” (Higher Education Funding Council for England, 2012). Black and Minority Ethnic (BMEs) describe people that may have experienced racism or are assigned “minority status because of their skin color and/or ethnicity” (Universities Scotland, 2010).

The PMI2 CMU-UWE project team examined factors in both countries at the secondary school, undergraduate and graduate levels that influence attraction, recruitment, retention, and career progression of underrepresented populations in STEM fields. Further, the entire team saw the mutual benefit of investigating sample environments, mandates, funding, and institutional approaches to broadening participation in the United States and widening participation in the United Kingdom.

CMU’s MS-RT (Master of Science and Robotics Technology) program and representatives of government mandated campus-wide diversity initiatives at UWE that formed the project team adopted a multi-pronged approach to structure activities:

- Identifying US and UK local and national promising practices in broadening participation / widening participation;
- Exploring the unique configuration, history, and contributions of Historically Black Colleges and Universities (HBCUs);

- Completing a literature review (e.g. research reports, journals, and popular media articles);
- Structuring learning visits for the PMI2 CMU-UWE team to explore and observe case studies of broadening participation strategies and challenges (via interview, observation, interaction, etc.) as a basis for guiding future joint activities; and
- Disseminating results with colleagues, BP/WP practitioners, and education advocacy and policy organizations:
 - CMU team poster presentation at the 2011 Pennsylvania Council for International Education (Appendix 1);
 - CMU-UWE team poster presentation at the 2012 Going Global Conference (Appendix 2);
 - UWE hosted conference on widening participation in STEM; and
 - *Finding the Keys to Growing the Underrepresented Student Groups in STEM* – this technical report.

Part I

CARNEGIE MELLON UNIVERSITY



AND

UNIVERSITY OF THE WEST OF ENGLAND

The PMI2 Collaborative Partners were Carnegie Mellon University's Master of Science in Robotics Technology Program and the University of the West of England's Faculty of Arts, Creative Industries, and Education and the Faculty Environment and Technology.

Although the Carnegie Mellon University and the University of the West of England both function in the higher education arena, interest areas for information gathering in this project differed for each partner. For this investigation, the CMU focus was the advancement of undergraduate students from underrepresented populations in STEM disciplines to graduate education. On the education continuum from secondary school level through higher education (undergraduate, graduate and terminal degree), UWE expressed particular concern with the progression of students from low social economic backgrounds and Black and Minority Ethnic (BME) groups from secondary school to higher education.

1. Carnegie Mellon University (CMU)

Carnegie Mellon University (www.cmu.edu) is a global research university advancing science, community, and quality of life. The university is consistently ranked as one of the best in the world.

- The Times Higher Education 2011-2012 World Rankings ranks CMU number 21 in North America (The Times, 2011);
- The university was most recently ranked number 12 in the world for subject area engineering and IT (Information Technology) (The Times, 2011); and
- US News and World Report 2013 best national universities places CMU at number 23 and notes CMU contributions in “engineering, business, computer science, and fine arts” (US News & World Report, 2012).

Diversity is a guiding principle at Carnegie Mellon University. University leadership states that “diverse perspectives and backgrounds breed the intellectual vitality essential for the health and

progress of the university” (Carnegie Mellon University, 2012). President Jared Cohon explained

Simply put, becoming more diverse will make Carnegie Mellon and the work it does better. Certainly, our students will be better-educated for having learned and lived in a multicultural community. Our research and service will be different—and some of it better in its transfer to and impact on society—as a result of the multiple perspectives brought to us by diversity (Carnegie Mellon University, 2012).

University activities and programs that promote diversity are explored in the “Learning Visits” section of this paper. For example, in robotics research and education, faculty member Dr. David Touretzky co-led Advancing Robotics Technology for Societal Impact (<http://artsialliance.org/>) a National Science Foundation funded broadening participation alliance that coupled 17 historically black colleges and universities with 9 research universities (US National Science Foundation, 2008).

2. CMU’s Master of Science in Robotics Technology

Carnegie Mellon University's PMI2 collaborative team members lead the Master of Science in Robotics Technology (MS-RT) program in the Robotics Institute, an academic department in the university's School of Computer Science.

The MS-RT is a two-year professional masters degree program. The first year is delivered by a partner university with CMU's support. The second year is delivered by CMU at its main campus (Pittsburgh). The students' summer in between the two academic years is spent in an industrial immersion experience. The program to date has focused on partner universities in still-developing countries and in developed countries with established feeder streams from still-developing countries. Two unique features set the MS-RT apart from typical professional masters degree programs:

- an anti-brain-drain philosophy that explicitly recruits and focuses on developing students who intend to apply their learned technical skills entrepreneurially for sustainable development in their home countries; and
- the implementation of this focus in substantial part via an Extended Project Course Sequence that integrally spans the two semesters with CMU's partner university, the summer industrial immersion experience, and the two semesters with CMU.

Most partner universities prefer to structure the program with a dual-degree requirement or option. MS-RT partner universities are generally enthusiastic about the prospect that US students would be interested in doing the first year MS-RT program as international students at their campuses. The program expects that program graduates who follow this path would be particularly enthusiastic about and qualified for careers as overseas representatives of US companies operating abroad.

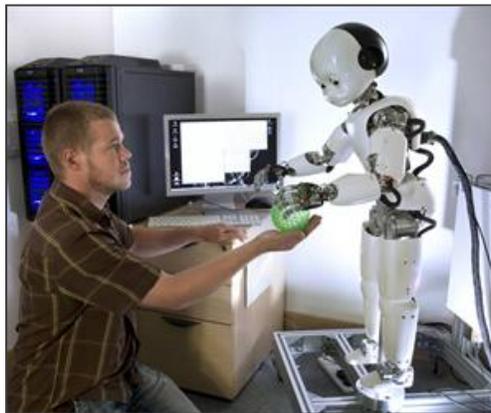
The relatively recent realization that contributed to CMU's particular role in the present study and this resulting report was that MS-RT partner universities that meet all of the educational and philosophical requirements of the program's focus can be found not only internationally, but also domestically in the HBCU system: financially challenged students who appreciate the economics of doing the first program year at their home universities and excellent institutional understanding of and willingness to teach the personal and societal rewards open to technically excellent and entrepreneurially minded students.

One of the MS-RT program partners is Plymouth University in southwest England, the first university in the UK to offer an undergraduate program in robotics. The faculty-to-faculty and administrator-to-administrator interactions involved in operating this partnership have provided valuable insights into the study's key element of comparing and contrasting broadening participation issues.

[For reference, details of the CMU-Plymouth MS-RT partnership and the specific implementation of the program mode can be seen at



www.ri.cmu.edu/MS-RT and



www1.plymouth.ac.uk/courses/postgraduate/4342/Pages/CourseOverview.aspx

In addition to the Plymouth UK program, whose first cohort is now underway, there is a second cohort underway in China in partnership with Nanjing University of Science and Technology. There are completed agreements to begin recruiting cohorts with partners in Mexico and the Dominican Republic, and discussions underway (with various degrees of maturity) with many other potential partners. Regarding specifically the HBCU opportunity, serious planning is underway with a large HBCU and several smaller ones, with the concept being that a consortium would be formed in which the smaller colleges and universities would feed their most excellent undergraduates into the larger university's graduate program.

The spectrum of MS-RT partnerships reflects the diversity, competitiveness, and net-centric character of today’s international economy. The program approaches national strategic industrial, social, and economic development opportunities through human-needs-centered robotics and mechatronics. The program’s collaborative teaching, research project experience, and problem-solving approaches all aim at returning its graduates to their home countries and communities as ethical leaders and entrepreneurs who will dedicate themselves to job creation and sustainable social and economic development through robotics technology. The active international relationships of this program will be enhanced by identifying and implementing best practices in domestic diversity recruitment (i.e. extending access and opportunities to US and partner under-represented groups).

TABLE 2: Average ranking for the last 10 years of Carnegie Mellon among universities by U.S. News and World Report

	2004-2013
Undergraduate Engineering	8
Graduate Engineering	8

Source : <http://www.cmu.edu/about/rankings-awards/rankings/historicalrankings.pdf>

3. University of the West of England (UWE)

The University of the West of England leverages the power of partnerships, vision, mission, and ethos to INSPIRE (I innovate, N nurturing talent, S student experience, P participation, I internationalization, R research, and E exchange) (University of the West of England, 2012). The 2013 League Table Rankings place UWE at 58 (The Complete University Guide, 2013). The University of the West of England describes the purpose of its widening participation activities as supporting the “University in its core mission related to reaching out to and opening up opportunities for people from under-represented backgrounds, families, groups and communities and positively enabling such people to participate in and benefit from higher education” (University of the West of England, 2010). UWE staff reported that UWE won the very first national Xcel prize for the Widening Participation Institution of the Year (University of

the West of England, 2010). The University of the West of England PMI2 collaborative members were based at the Faculty of Arts, Creative Industries and Education and the Faculty of Environment and Technology.

Ms. Rachel Burcin and Ms. Angela Keiser, members of the PMI2 - CMU team who visited the University of the West of England in 2010, noted that differences in the composition of underrepresented groups and political environments in which UWE operates, clearly informs their approach and success. This is demonstrated by the tactics and wording in the following strategic documents:

Equality and Diversity at UWE

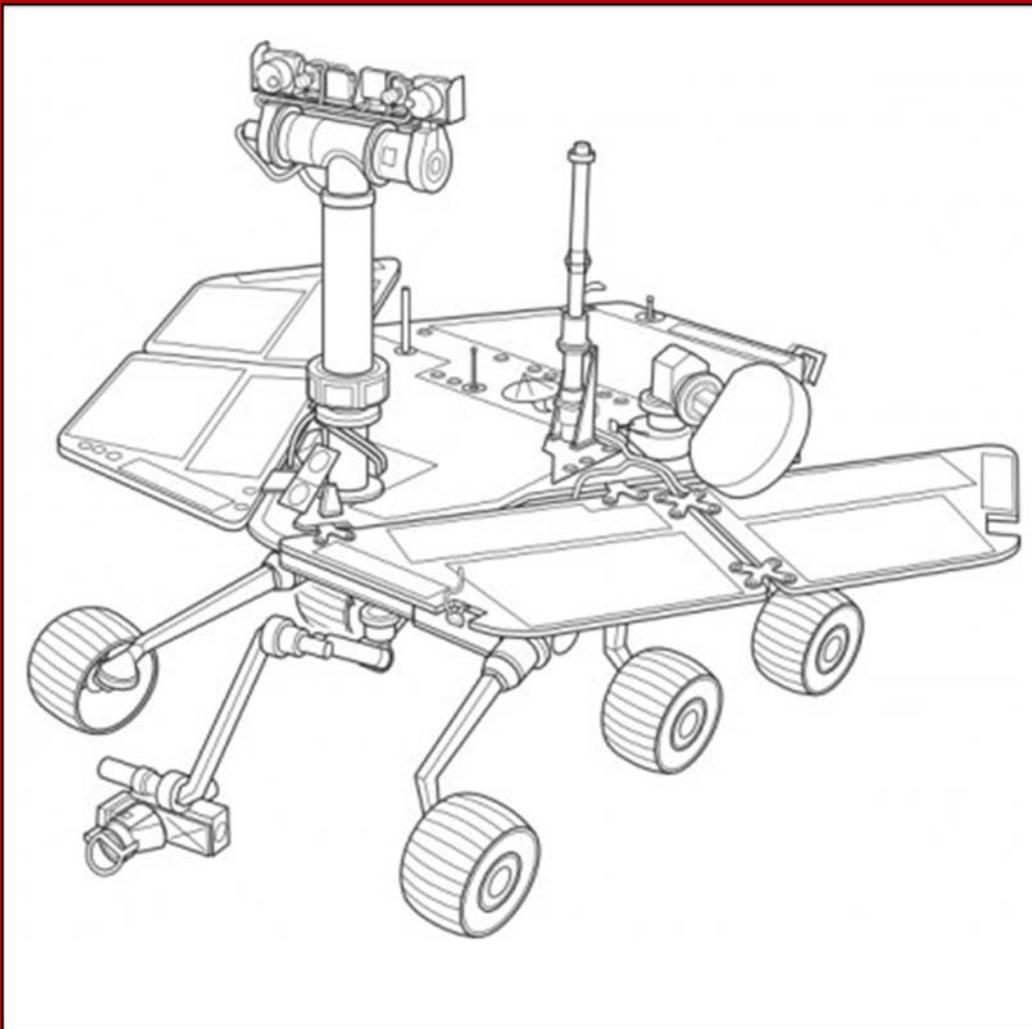
http://imp.uwe.ac.uk/imp_public/displayentry.asp?URN=6227&return=false&pid=1

Race Equality Scheme at UWE

www.uwe.ac.uk/groups/equalityanddiversity/docs/UWERESfinal_publishversion_29.05.09.pdf

Part II

THE EXPLORATION



Carnegie Mellon University (CMU) and the University of the West of England (UWE) formed a Prime Minister's Initiative grant award (PMI2) team to undertake a year-long exploration of common challenges, promising practices, and keys to growing the underrepresented student populations in STEM fields in both countries. Our literature review, learning visits, and observations validated that

- STEM matters: STEM fields and their applications are critical to the growth of world economies;
- Effective broadening / widening participation (BP/WP) practices, especially in STEM fields, is important for both countries;
- Historically Black Colleges and Universities (HBCUs) have constructed successful methods of attracting, retaining, inspiring, and graduating students from groups underrepresented in STEM fields; and
- There are a number of proven practices of recruitment, retention, and career launch that warrant further investigation by both US and UK partners.

4. STEM and Global Development

STEM fields, with their direct linkages to innovation, are essential to the future global competitiveness of the United States and United Kingdom. Robotics technologies, in particular, present powerful tools to rebuild US & UK industrial competitiveness. Both the US and UK face critical domestic STEM skills gaps and intensifying competition to recruit the best STEM talent globally. In light of these challenges and ongoing demographic changes, broadening participation in STEM has emerged as a national imperative. Here we explore the importance of STEM and challenges to developing the workforce necessary for STEM-led growth.

Government, industry, and education leaders in the United States and United Kingdom agree: STEM, with its direct linkages to innovation, enhances the global competitiveness of both countries. STEM and its applications are fundamental drivers in today's global economy.

Worldwide, governments and corporations are investing heavily in STEM and relying on its applications to compete globally.

Robotics technologies are powerful tools to rebuild US & UK industrial competitiveness.

Carnegie Mellon's Robotics Institute and University of the West of England's-Bristol University's joint Bristol Robotics Laboratory are recognized worldwide for their important contributions in robotics and intelligent systems. CMU and UWE each possess a special role in this emerging science and its consequent technology and engineering disciplines. Robotics is poised to make unique contributions to core economic sectors, including industrial and manufacturing, in the US and UK. Technology and a skilled workforce represent tremendous resources that can be leveraged to help developed nations compete with low labor cost regions worldwide. John Rice, General Electric's vice chairman stated that "competence will always trump cost" (The Economist, 2012).

The low labor costs of early stage industrial nations have eroded revenue growth of manufacturing sectors in developed nations. However, cheap labor is no longer the only avenue to lowest total cost of production.

A skilled STEM workforce fluent in the core stem skills (see table 3) can participate in efforts to transform failing and outdated industries into profitable production sites located on US and UK soil. Lower costs of production can be achieved through innovative technology applications working alongside skilled workers. In its 2009 report: *The Future of UK Manufacturing*, the Price Waterhouse Coopers research team posits that through innovation it is possible to move from survival mode to a thriving manufacturing sector (PriceWaterhouseCoopers, 2009). A similar resurgence of manufacturing is underway in the United States. At Carnegie Mellon Robotics Institute labs in 2011, President Barack Obama launched the Advanced Manufacturing Initiative, "a national effort bringing together industry, universities, and the federal government to invest in the emerging technologies that will create high quality manufacturing jobs and enhance our global competitiveness" (White House Press Office, 2011). STEM is firmly on US and UK national agendas.

TABLE 3: Core Knowledge domains associated with STEM occupations

CORE KNOWLEDGE DOMAINS ASSOCIATED WITH STEM OCCUPATIONS	
Production and Processing:	Knowledge of raw materials, production processes, quality control, costs, and other techniques for maximizing the effective manufacture and distribution of goods.
Computers and Electronics:	Knowledge of circuit boards, processors, chips, electronic equipment, and computer hardware and software, including applications and programming.
Engineering and Technology:	Knowledge of the practical application of engineering science and technology. This includes applying principles, techniques, procedures, and equipment to the design and production of various goods and services.
Design:	Knowledge of design techniques, tools, and principles involved in production of precision.
Building and Construction:	Knowledge of materials, methods, and the tools involved in the construction or repair of houses, buildings, or other structures such as highways and roads.
Mechanical:	Knowledge of machines and tools, including their designs, uses, repair, and maintenance.
Mathematics:	Knowledge of arithmetic, algebra, geometry, calculus, statistics, and their applications.
Physics:	Knowledge and prediction of physical principles, laws, their

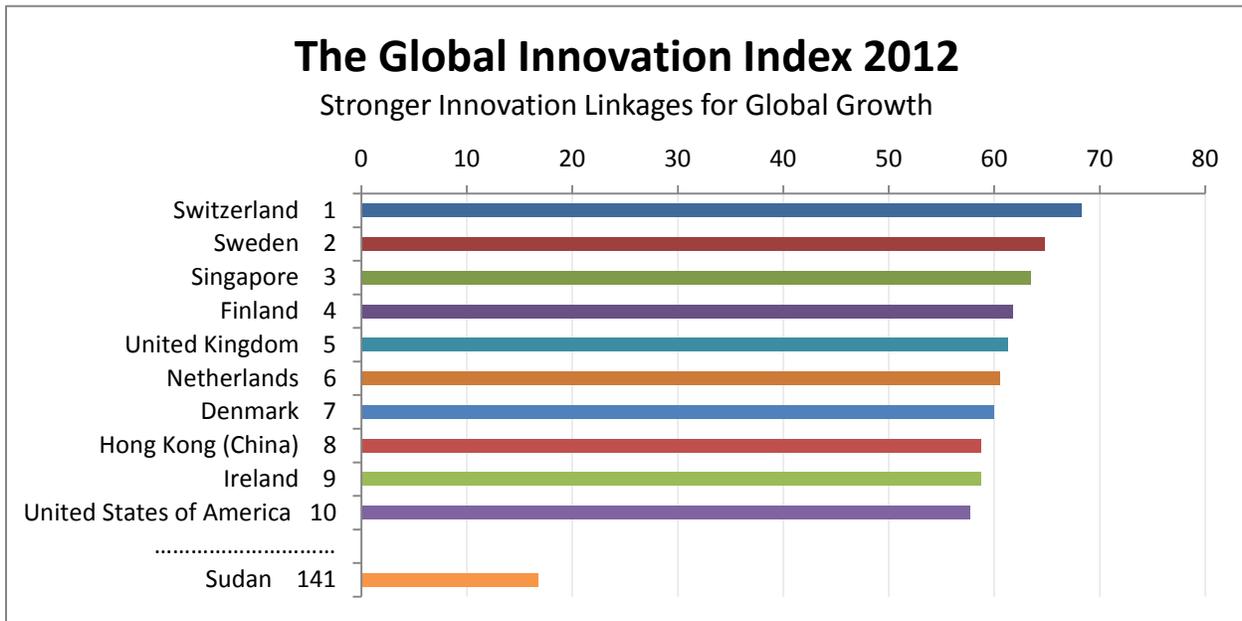
	interrelationships, and applications to understanding fluid, material, and atmospheric dynamics, and mechanical, electrical, atomic, and subatomic structures and processes.
Chemistry:	Knowledge of the chemical composition, structure, and properties of substances and of the chemical processes and transformations that they undergo. This includes uses of chemicals and their interactions, danger signs, production techniques, and disposal methods.
Biology:	Knowledge of plant and animal organisms and their tissues, cells, functions, interdependencies, and interactions with each other and the environment.

Source: Georgetown Center on Education and the Workforce, *STEM*

5. STEM and US and UK Economics

US and UK national economic development plans rely heavily on STEM and resulting innovations. To lead and implement these plans, nations requires a workforce and pipeline of new entrants trained in critical STEM skills. CBI, a top United Kingdom business organization, reports that in the United Kingdom, “STEM skills shortages are widespread - 43% of employers currently have difficulty recruiting staff, rising to more than half of employers (52%) expecting difficulty in the next three years” (CBI, 2011). If unaddressed, the growing domestic skills gap could become a chronic weakness, wreaking havoc on production, output, and national competitiveness. While the UK ranking in global innovation has remained fairly strong, the US has tumbled in global innovation rankings from number one to number ten (World Intellectual Property Organization and INSEAD, 2012).

TABLE 4: Global Innovation Index 2012



Source:

http://www.globalinnovationindex.org/gii/main/analysis/rankings.cfm?vno=&viewall=true#CGI.SCRIPT_NAME#

The emergence of technology innovation zones (e.g. Singapore, ShenZen, Bangalore, and Shanghai) across the globe has intensified an already competitive global labor market. Quality of life and career opportunities are increasing in China, India and other traditional sources of STEM workers. As the global talent market tightens, neither the US nor UK can rely principally on international students, foreign-born scientists, or immigrants to fill domestic STEM skills gaps. In light of the above, broadening participation has emerged as a national imperative in both nations.

STEM fields are vital to national growth and prosperity and therefore, firmly within the national interest. The [United Kingdom] Government has made clear that education and hi-tech industry are vital to its plans to generate economic growth. However without a highly skilled and knowledgeable workforce that will not be possible. It is vital therefore that higher education in the UK has a strong STEM sector and is able to produce the graduates and postgraduates hi-tech industries will demand” (Willis, 2012). The domestic STEM skills gap and increasing global competition for STEM talent represents a gathering storm. It is imperative that education leaders

in science, engineering, and technology respond in a thoughtful and innovative way to these challenges.

6. Broadening Participation

The US and UK census results confirm that the face of the nation is changing. Demographic changes will have a profound impact of workforce composition. White males, demographically in decline, have traditionally dominated the domestic STEM workforce. As the population of underrepresented groups (e.g. ethnic minorities and women) grows, it will become ever more critical to develop effective recruitment, preparation, and retention of these groups in STEM. The US National Science Board statement below reflects the need to broaden participation in STEM fields:

“To ensure the long-term prosperity of our Nation, we must renew our collective commitment to excellence in education and the development of scientific talent. Currently, far too many of America’s best and brightest young men and women go unrecognized and underdeveloped, and, thus, fail to reach their full potential. This represents a loss for both the individual and society” (National Science Board, 2010).

The US National Commission on National Security warns:

“The scale and nature of the ongoing revolution in science and technology, and what this implies for the quality of human capital in the 21st century, pose critical national security challenges for the United States. Second only to a weapon of mass destruction detonating in an American city, we can think of nothing more dangerous than a failure to manage properly science, technology, and education for the common good over the next quarter century” (U.S. Commission on National Security/21st Century, 2001).

Through educational outreach and student supports, CMU and UWE are actively engaged in developing the technical talent of underrepresented domestic student groups in STEM fields. As

part of this collaborative survey project, CMU and UWE conducted joint learning visits to explore promising and effective practices in broadening participation in the US and widening participation in the UK. These learning visits are explored in the next section.

Part III

LEARNING VISITS



A major part of the joint venture was PMI2 CMU-UWE team learning visits to each partner institution and an inspection of its support environment. CMU developed a two-part U.S. itinerary (Washington, DC and Pittsburgh PA) that explored broadening participation efforts at the national level and two regional experiences. The bipartite team met with government and public organizations concerned with education policy and a variety of higher education institutions (e.g. state supported, private, religious, etc. with student bodies varying in enrollment size, economic and racial compositions).

7. Historically Black Colleges and Universities (HBCUs)

The learning visits began with Historically Black Colleges and Universities (HBCUs) in the Washington, DC area. Prior to this PMI2 collaborative, UWE team members were unfamiliar with the history and configurations of HBCUs and no partnership agreements between UWE and HBCUs existed. Therefore, exploring American Historically Black Colleges and Universities and partnership possibilities was of particular interest to the Bristol-based PMI2 team members since no such model exists in their country. Widening participation initiatives remain in play on campuses in the UK, in accord with the government agenda to expand availability of higher education to all who could benefit from it. This was expressed in the January 2003 White Paper “The future of higher education” presented to Parliament by Charles Clarke, Secretary of State for Education and Skills by Command of Her Majesty (Clarke, 2003).

Historically Black Colleges and Universities (HBCUs) claim a unique history and a special position in the higher education domain. With roots extending back as far as an 1830's Pennsylvania teacher training institute (Cheyney University, 2011), HBCUs offered intellectual advancement to Americans of African descent barred by U.S. racial segregation laws from attending schools open to their white counterparts. Sixteen exclusively black institutions received 1890 land-grant funds via the second Morrill Land-Grant Act which specified that states using federal land-grant funds must either make their schools open to both blacks and whites or allocate money for segregated black colleges to serve as an alternative to white schools (United States Congress, 1890).

HBCUs serve a dynamic function for all learners in today’s world. Technically identified as institutions established prior to the passage of the 1964 Civil Rights Act (National Archives and Records Administration, 1964), there are approximately 105 HBCUs located in the United States and the US Virgin Islands that educate students of color while maintaining open admissions policies attracting a cross-section of ethnicities, nationalities and cultures (White House Initiative on HBCUs, 2012). While restrictive national racial policies have been dismantled, the HBCUs continue to play a vital role in education. Present HBCU student bodies reflect a growth in non-Black and international enrollees. The opportunity to share intellectual and social insights with peers from environments differing from the typical HBCU student background (e.g. - Southern, Eastern, Caribbean, urban, suburban, rural, homogeneous, etc.) is a mutually enriching experience as well as a useful preparation for professional life in a globalized society (Gurin, 1999).

The Historically Black Colleges and Universities represent an avenue of access to professional training previously unavailable to financially challenged, academically or geographically isolated populations.

“Students Speak”, a report based on a comprehensive assessment conducted between May and December 2009 and issued by the United Negro College Fund, delineates an assortment of perspectives on why African-American students chose to attend an HBCU (Awokoya, 2011). Among the volume of reasons expressed, students gave high priority to their desire for a strong sense of belonging. Report findings indicated a need to feel connected and welcomed. HBCU institutional characteristics of small class size, faculty approachability and a family-oriented environment helped speed adjustment to college life. Young scholars of color in the study also positively ranked the automatic sense of community offered at HBCUs as well as a sense of cultural pride and identity (Awokoya, 2011).

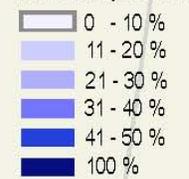
There is mutual untapped value for U.K.-based Black and Minority Ethnic (BME) student groups in a partnership with HBCUs.

TABLE 5: Percentage of Americans College Graduates who received their degrees from HBCUs, per State (based on a 3-year average 2009-2011):

Percentage of African Americans College Graduates who received their Degrees from HBCUs, per State.

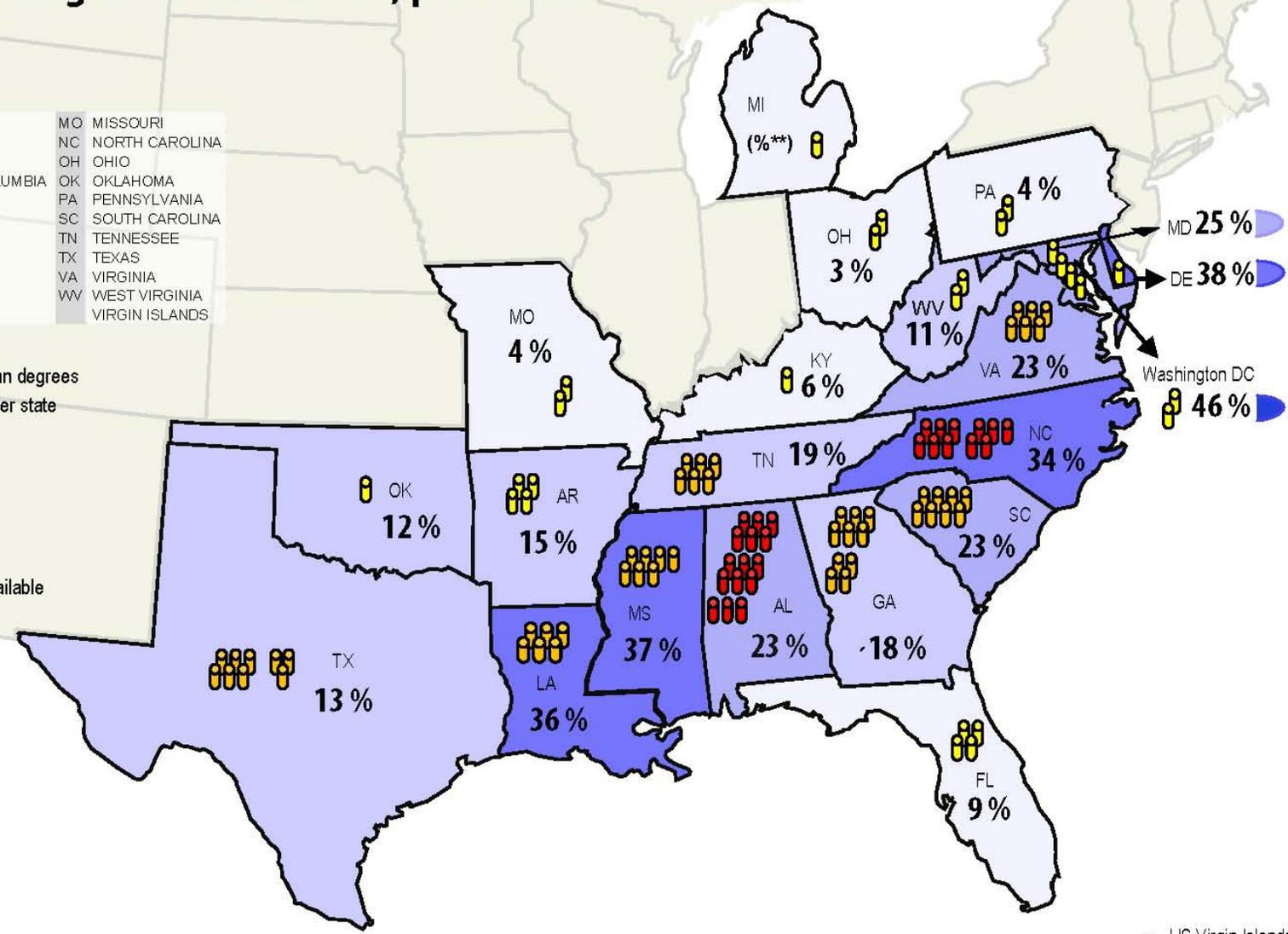
AL	ALABAMA	MO	MISSOURI
AK	ARKANSAS	NC	NORTH CAROLINA
DE	DELAWARE	OH	OHIO
DC	DISTRICT OF COLUMBIA	OK	OKLAHOMA
FL	FLORIDA	PA	PENNSYLVANIA
GA	GEORGIA	SC	SOUTH CAROLINA
KY	KENTUCKY	TN	TENNESSEE
LA	LOUISIANA	TX	TEXAS
MD	MARYLAND	VA	VIRGINIA
MI	MICHIGAN	WV	WEST VIRGINIA
MS	MISSISSIPPI		VIRGIN ISLANDS

% of African American degrees awarded by HBCU per state



** MI: Data not available

HBCUs per State



US Virgin Islands
100 %

Source: White House Initiative on Historically Black Colleges and Universities at <http://www2.ed.gov/about/inits/list/whhbcu/edlite-list.html>

8. Igniting partnership between HBCUs and UK universities

Since the HBCU network was unknown by the University of the West of England prior to this PMI2 grant-supported exploration, these singular American institutions of higher learning offer a fresh pool of willing candidates to engage in sustained international collaborative programming. Further, during the course of meeting with the National Association For Equal Opportunity (NAFEO) in Higher Education, an esteemed membership organization representing the interests of HBCUs to governments, corporations and foundations, the PMI2 CMU-UWE Team was told that the expansion of international ties is an immediate goal for HBCUs.

The United Kingdom remains among the top 10 most popular hosts for study abroad by students enrolled in U.S. higher education (IIE, 2011). From the perspective of minority students enrolled in STEM disciplines with limited or non-existent experiences abroad, a potential relationship between higher education partners such as University of the West of England and the HBCU Morgan State University for example, can be low- stress. A point of commonality between Morgan State University and UWE touched on during discussions at the Morgan State campus was the number of student body members in both institutions that identified with their Caribbean heritage. Working with this commonality, the construction of an abroad experience as an introduction to polishing necessary 21st century workforce skills would incorporate a relative level of comfort in working with those from a similar heritage yet with a different background in cross-cultural environments.

9. University Outreach

UWE had a specialized focus on successful activities that support the transition of low social economic background students and Black and Minority Ethnic (BME) students from secondary to higher education (University of the West of England, 2011). The PMI2 CMU-UWE team explored US efforts to support successful transition of similar students in Pittsburgh by interviewing:

- Pittsburgh Foundation, administrators of ‘The Pittsburgh Promise’ – the city’s unique community commitment to help students in local government-funded K-12 schools plan, prepare and pay for education beyond high school

www.pittsburghfoundation.org/pittsburgh_promise);

- A+ Schools, an independent citizens’ advocacy group for the improvement of public education (www.aplusschools.org); and
- Pittsburgh Science and Technology Academy (Grades 6 – 12) where any student with an interest in STEM area coursework can develop skills for a career in life science, environmental science, computing, or engineering. Admission to SciTech is determined by a weighted lottery. (<http://www.pps.k12.pa.us>).

Of special interest were visits to Howard University (Washington, D.C.) and Morgan State University (Baltimore, MD) - Historically Black Colleges and Universities (HBCUs). These HBCU campuses represent an academic designation not found in the United Kingdom.

TABLE 6: PM12 CMU-UWE Team United States itinerary

DATE	ORGANIZATION	DESCRIPTION
2-Nov-11	National Association For Opportunities in Higher Education (NAFEO) 209 3rd St, SE Washington, DC 20003 www.nafeo.org	Membership advocacy group representing HBCUs & Predominantly Black Institutions (PBIs) to federal, state governments, corporations & funders

3-Nov-11	Morgan State University 1700 E. Cold Spring Lane Baltimore, MD 21251 www.morgan.edu	Designated by the Maryland General Assembly as the State's public urban university, MSU's mission is to provide an excellent education to those who have the potential to complete degree requirements.
	British Council, USA British Embassy 3100 Massachusetts Ave, NW Washington, D.C. 20008	With offices on six continents, B.C. re-energizes transatlantic relations with work on shared agendas in higher education, the arts & civil society.
4-Nov-11	Howard University 2400 6th St, NW Washington, DC 20059 www.howard.edu	An HBCU, Howard is one of only 48 US private, Doctoral / Research Extensive universities
5-Nov-11	Travel from WASHINGTON, DC to PITTSBURGH, PA	
7-Nov-11	Carnegie Mellon University Robotics Institute 5000 Forbes Ave Pittsburgh PA 15213 www.ri.cmu.edu	Established in 1979, the Robotics Institute, part of the School of Computer Science, conducts basic and applied research in robotics technologies.
	Intercultural House 272-274 N. Dithridge St Pittsburgh PA 15213 www.interculturalhouse.org	This 40-year old non-profit organization provides housing for undergrads as part of a living-learning experience aimed at targeting & eradicating racism.

8-Nov-11	<p>Carlow University 3333 Fifth Ave Pittsburgh PA 15213 www.carlow.edu</p>	<p>A small, comprehensive Catholic masters university with roots that reach back to the 1930's.</p>
	<p>University of Pittsburgh Swanson School of Engineering 3700 O'Hara St Pittsburgh PA 15261 www.engineering.pitt.edu</p>	<p>According to Newsweek's listing of the top 100 Global Universities, Pitt ranks 10th among public US universities.</p>
9-Nov-11	<p>A+ Schools 1901 Centre Ave Pittsburgh PA 15219 www.aplusschools.org</p>	<p>A+ Schools is a Pittsburgh's community Alliance for Public Education, a well-respected independent citizens' advocacy group for the improvement of public education.</p>
	<p>Pittsburgh Science and Technology Academy 107 Thackery St Pittsburgh PA 15213 www.pps.k12.pa.us</p>	<p>In Grades 6 – 12, SciTech offers any student with an interest in STEM area coursework the opportunity to develop skills for a career in life science, environmental science, computing, or engineering.</p>

Part IV

PROMISING STRATEGIES TO:

RECRUIT

RETAIN

GRADUATE



**UNDERREPRESENTED STUDENTS
IN
STEM
FIELDS**

This section summarizes relevant comments garnered from meetings that comprised the US itinerary of the PMI2 CMU-UWE Team (with its stronger postgraduate emphasis) and highlights selected participant contributions. As previously indicated, the main objective of the strategic partnership struck between Carnegie Mellon University and University of the West of England was to explore promising practices and common barriers encountered in the recruitment, retention and graduation of underrepresented students in STEM fields. The PMI2 CMU-UWE team members explored a variety of ways to address successful recruitment, retention and degree completion of underrepresented student populations in STEM fields, including:

- Campus-wide engagement;
- Undergraduate Minority Recruitment and Retention Strategies; and
- Complimentary Policymaking Support.

10. Campus-wide engagement

The campus visit to Morgan State University (MSU) included a full assembly of Department Chairs, Deans and University central administration involved with STEM discipline instruction. Dialogue during this gathering led to insight on how the training areas represented at the gathering chose to address the issue of promoting interest among students to choose and stick with studies in the STEM disciplines.

Campus-wide Action: There has been a general re-distribution of class content across disciplines. Faculties have been encouraged to re-tool the amount of information presented and the mode of instructional delivery per class over the term to make room for more self-directed activity, increased student analysis and application of course content.

The School of Education has re-designed its curriculum offerings to highlight teacher training in STEM areas. Among the program offerings is a Master's Degree in STEM Education. The graduate program for Business Administration continues to maintain 3 staff members specifically for retention and student support in STEM studies. In an effort to blend STEM

discipline applications, community service and real-world need, a MSU administrator chairs a consortium of HBCU institutions that is helping to rebuild the earthquake-damaged State University of Haiti, the Caribbean country's largest facility.

To define what makes Morgan State University (a Minority-Serving Institution) distinct from other in-state higher education (HE) institutions, the following points were repeatedly referenced:

- Students of color have the psychological reinforcement of seeing productive campus faculty who look like them, making it easier to link to role models;
- A campus-wide culture of student nurturing and peer support permeates the MSU community from the Provost's Office through faculty, staff and student services. Faculty strives for verbal reinforcement of student capabilities;
- Faculty reinforcement of the University's point of view: STEM studies are welcoming places for minorities. This is reflected by the prominent placement of STEM programs at HBCUs. Each student has a contribution to make. How can the MSU 'family' best help students envision those contributions? and
- A concerted effort is put into minimizing the time spent on limiting students based on their test scores. Instructors are prompted to encourage student interest in STEM activities and coursework. If learners demonstrate workload competence, persistence and enthusiasm for the experience, faculty will continue to work with individuals to the extent of their abilities in spite of prohibitive test rankings. A sincere effort is put forth by teachers to distinguish in their students the measure of content mastery skills versus test-taking skills.

11. Undergraduate Minority Recruitment and Retention Strategies

What activities can an urban university conduct to attract minority candidates with the potential for success in STEM disciplines? There are 8 other colleges within 20 minutes of Pittsburgh's CMU campus. Broadening participation and minority access activities have placed CMU in the forefront of this group (Carnegie Mellon University, 2012). By necessity the truncated visit precluded the team visiting with a fuller range of relevant CMU programs on campus.

The Office of Assistant Vice Provost for Graduate Education at Carnegie Mellon University demonstrated promising practices across a range of activities that support the recruitment, retention, and progression of underrepresented students in STEM fields. The Office has developed specific action areas and programming that supports undergraduate minority recruitment and retention. The Office cultivates functional and mutually beneficial working relationships with Historically Black Colleges and Universities (HBCUs), minority serving majority institutions, minority programs in Predominantly White-serving Institutions (PWI) as well as tribal colleges and other higher education institutions serving populations of Native Americans and Hispanic-serving Institutions (HSIs). Under the leadership of Dr. Suzanne Laurich-McIntyre, the Office of Assistant Vice Provost for Graduate Education systematically brings individual students of promise to the attention of separate STEM field departments within the university community. This office sustains the Fusion Forum, a program that responds to an essential question asked of this recruitment population: “How can you use your graduate degree to help your community?”

Student information cards are collected from potential CMU candidates at symposia, conferences, and other gatherings convened at schools offering training that meets CMU admissions criteria. Interested applicants are channeled to individual departments. Students entering the academic system through this graduate office’s services are tracked. Those who have come to CMU, usually remain through graduation. This recruitment strategy targets ‘advanced studies placement’, high achieving, financially challenged learners. Since graduate level admissions are consummated at the departments’ discretion, there is value in bringing individual students who demonstrate promise to the attention of separate STEM field departments.

Other underrepresented student recruitment and retention strategies in practice at Carnegie Mellon University include:

- *Women@SCS* (www.women.cs.cmu.edu): encourages participation and supports female undergraduate students, graduate students, and faculty members throughout the School of Computer Science with programming, outreach, and mentoring;
- *Professional Development Series*: A sequence of activities requiring students to ‘role play’ scenarios commonly encountered by a variety of STEM career professionals;

- *Advancing Robotics Technology for Societal Impact* (www.artsalliance.org) a National Science Foundation-sponsored broadening participation project: A consortium with approximately 17 HBCUs is building a pipeline to future terminal-degree minority candidates through expansion of robotics course offerings, and summer research laboratory internships; and
- *K-12 Robotic Happenings*: Primary, elementary and secondary pupils welcome undergrad presenters into their classrooms. Together they explore up close what makes a robot work.

Howard University, a mid-size Washington DC urban institution and an HBCU, matched Carnegie Mellon's enthusiasm for recruiting to their graduate STEM programs minority candidates exhibiting the markings of success. The University's Department of Systems and Computer Science also exchanged views with the PMI2 CMU-UWE team on its approach to successful student retention. The Department insists on small class size. This allows for individualized student attention. In addition to receiving more personally tailored instruction and more frequent opportunities to actively participate in class discussions, learners tend to gain greater self-confidence.

One of Pittsburgh's small local colleges added its own creative touches to several engaging activities to attract underrepresented learners to enrollment. Core values within the mission statement of Carlow University are the starting points for many of the school's best practices for recruitment and retention of students, especially minorities. Anticipating the needs of Carlow's adult commuter population, a cross-registration option is in operation. This option allows matriculated Carlow University students to sign up for coursework offered at any accredited regional consortium institution through the aegis of the Pittsburgh Council of Higher Education (PCHE). Through cross-registration, Carlow students are eligible to take coursework at CMU and University of Pittsburgh among other consortium members. This option represents an opportunity to sample STEM classroom work; recognizes the commuting or working students' need for flexibility in class scheduling as well as the students' (especially minorities) need to find the right instructional or social 'fit'. The CMU-UWE Team met with the Director of Diversity Initiatives, Ms. Barbara Johnson. In a structured move to broaden and personalize awareness of the issues associated with diversity and inclusion, the highly successful *Diversity Dialogues Series* has been instituted. On a regular basis, teaching colleagues and staff are invited to share their own personal stories of how they've experienced diversity with the Carlow student

community. The required coursework at Carlow's School of Education includes instruction regarding culturally appropriate pedagogy. Additionally, students are encouraged to take advantage of the Vista volunteer experience.

12. Complimentary Policymaking Support

Morgan State University President Wilson presented a major question that guides his decision-making on minority student offerings in STEM coursework: 'How can the university best attract and serve learners who have, up to this point, navigated the financial and psychological challenges of the academic system?' Drawing from his rich professional experience (www.morgan.edu/Office_of_the_President/Biography.html), Dr. Wilson pointed out for the benefit of the CMU-UWE Team a noteworthy example of successful practices:

- The variety of year-round undergraduate academic support, summer medical/dental/research programs and activities targeting secondary school attendees conducted through the Office for Diversity and Academic Success in the Sciences (ODASIS), a support unit within the Division of Life Sciences at Rutgers, The State University of New Jersey (<http://odasis.rutgers.edu/>) and Wisconsin's Project Lead The Way (www.pltwwi.org/).

Influenced by these models, Dr. Wilson encourages the following policies on campus:

- A mandated faculty push to implement re-distribution of class content. Instructors are encouraged to ask the hypothetical question, "Can a multi- credit's worth of instructional material be spread out over more days as opposed to fewer days to promote better absorption by students of the concepts being presented?" Discussions of course re-designs are part of departmental meetings and faculty reviews;
- More frequent use of supplemental, self-directed student reviews via an archive of recorded lectures; and

- Broader faculty participation in supplemental instruction through contributions to the recorded archive.

The University of Pittsburgh also appeared to have a broad base of administrative support through enforcement of policy recommendations in its attempts to build equitable access to success in STEM. With the backing of university administration, a standing priority goal for all departments is to boost the enrollment of minorities (<http://www.engineering.pitt.edu/diversity/>). Dr. Sylvanus N. Wosu, Associate Dean for Diversity Affairs promotes participation in the Mentoring Program for Engineering Excellence (MPE2).

Prior to the introduction of student-instructor mentoring, diversity training was provided for all participating faculty. Wosu encourages faculty to espouse sincere behaviors that verbally reinforce student capabilities especially for minorities (i.e.-positive reinforcement). His Office adheres to the American Association of Universities' *Inclusive Excellence Model* (Williams, Berger, & McClendon, 2005). Mechanisms were devised to engage, reward, and hold accountable all University of Pittsburgh multidisciplinary teaching staff that contributed to the mentoring initiative. The Associate Dean introduced personnel review policy changes that recognized and included contributions to widening participation as part of the annual faculty ratings. This was explained as a measure that helped faculty to see specifically what they are doing in their individual situations to broaden access to instruction and opportunities for minorities. Dr. Wosu cautioned the CMU-UWE Team that diversity programs oftentimes fail because the institution's administration is not engaged. Likely there is not a clear understanding of the resources that are needed to recruit, retain and graduate non-traditional populations.

The CMU-UWE Team turned to its grant administrator – The British Council - for examples of policymaking support. The British Council continues to host *Going Global*, a series of international educational conferences that offers an open forum for policy makers and practitioners from around the world to discuss issues facing the international education community. Since its inception in 2004, *Going Global* has grown to an annual event (<http://ihe.britishcouncil.org/going-global>). Alternating between the UK and a different international location, the conference welcomes over 1000 delegates from around the world representing higher education sectors and a variety of other industries with perspectives on improving international education.

The Education Program Arm of the British Council, USA continues to cultivate new partnerships for the 21st century with the Historically Black Colleges and Universities, as an example, in an effort to internationalize homeland education systems and escalate the breadth of professional experiences in the STEM areas. Internationalization is at the core of British Council obligations. The Council is committed to working with institutions around the globe to join forces in research, teaching and interface experiences. In regard to STEM Studies, for example, there is in place an engagement with the James Dyson Foundation that supports design and engineering education for youth. With budget cuts on the rise and enrichment opportunities on the wane, these sizeable groups of Chicagoans were less likely to have STEM related instruction in their classrooms, career role models in their schools or exposure to the excitement of hands-on engineering and design. Paving the way for broadening participation of students such as these Chicago residents in STEM experiences, the Dyson Foundation chose to launch its work in the United States by initially concentrating on Chicago Public Schools during the 2011-12 school year. The Foundation formed 20 after-school engineering clubs to encourage American students to become future engineers and inventors. Subsequent activities are scheduled to include teacher training tools and university scholarships (James Dyson Foundation, 2011).

There exists a need to recognize the impact of external influences on STEM recruitment, retention and degree completion.

13. Funding

A NAFEO legislative staffer discussed oversight of the dilemma faced by HBCUs with current Congressional cutbacks in Pell grants, Title III and other federal higher education funding. With a sizeable percentage of the minority student populations dependent on this financial assistance, there may be a notable impact on future class enrollment figures and the subsequent resources and enrichment experiences these institutions offer.

This scenario was driven home at the Morgan State University meeting where it was stated that budget cutbacks have diminished the number of full-time instructors, giving urgency to the need for more student financial support, more tuition assistance, fellowships, and scholarships. Multiple MSU department leaders spoke to the pressing need for increasing substantive

research and work - world experiences domestically and out-of-country for students prior to graduation.

Serving the K-12 population, The Pittsburgh Promise is part of a national community-based, urban model predicated on a regional desire to support the area's projected economy growth and expanding employment market. Through its Foundation, students graduating from the Pittsburgh public schools with a pre-stated grade point average will have their in-state college education subsidized.

14. Early Intervention - University Partnerships

Howard University Computer Science faculty explained current early intervention activities. The Department has joined forces with Google, Inc. and the Howard University Middle School of Math and Science to create the Partnership for Early Engagement in Computer Science (PEECS). Under the direction of Dr. Alicia Washington faculty participants teach technology fundamentals to students using culturally relevant content.

Since 64% of Pittsburgh public school enrollment is comprised of underrepresented populations (Pittsburgh Public Schools, 2010), a lot of energy has been put into University of Pittsburgh pre-college programming: e.g.- an 8th grade pre-engineering success program to promote and support academic excellence in groups traditionally underrepresented in the sciences, technology, engineering and mathematics; a 9th grade full year + one summer experience; a 9th through 12th grade three-year, engineering focused program; summer internship experiences (Swanson School of Engineering, 1988). These programs operate from the premise that students want to be respectfully engaged and challenged by the work.

The recently established Pittsburgh Science and Technology Academy 6-12 (SciTech) is prepared to accommodate an eventual enrollment of 550 students in grades 6 through 12 (Pittsburgh Science and Technology Academy 6-12, 2009). Graduates receive an honors diploma that recognizes successful completion of advanced coursework in STEM fields. Admitted to SciTech through a weighted lottery system, the current student body is self identified as approximately 40% White, 50% African-American, with the remainder in categories

of Asian, Hispanic, and Multi-racial. The gender balance at SciTech is approximately 66% male, 34% female (SciTech, 2011).

There exists a need for cultural and social supports to accompany STEM recruitment, retention and degree completion of underrepresented populations.

Pittsburgh's InterCultural House, a not-for-profit, undergraduate student focused organization promotes as its mission, the identification, understanding and elimination of the root causes of racism in the United States, primarily through a living-learning college experience (<http://www.interculturalhouse.org/>). Throughout the school year, student-fellows residing at ICH are committed to 'dialogue evenings' discussing topics revolving around race relations. The student-fellows are the lifeblood of a mentoring program with the local public schools. ICH alumni are products of a collegiate experience that promotes community engagement and allows for the practice of civic leadership.

During a conversation with a representative group from Inter Cultural House that included the founder, John Tyler, current and former board members, staff and external supporters, the ICH group cited individual student histories illustrating the need for an environment such as the one provided by ICH has not diminished. The ICH experience confronts student-participants with the challenge of defining the similarities and unique distinctions within the American narrative.

Community engagement is also a defining goal of A+ Schools (<http://www.aplusschools.org/>). The organization believes effective community engagement yields broadly based community participation in public education. To that end, A+ Schools distributes reports to the public on its community meetings conducted throughout the city. The organization maintains a volunteer citizens' Board Watch group, trained to observe and report on Pittsburgh Public School Board meetings. From these and other observations, A+ Schools issues a Board Watch Report Card (A+ Schools, 2002).

The better-informed parents and caregivers become, the more likely it is that they will capitalize on opportunities for academic advancement available to youth in their care. This is a proven way to assure accountability and high standards for Pittsburgh's students. A+ Schools attempts to counteract minimal personal interactions with schools and lowered engagement with school activities usually associated with lower household education attainment data.

CONCLUSION

Through a Prime Minister's Initiative grant award, Carnegie Mellon University (CMU) and the University of the West of England (UWE) undertook a year-long exploration of common challenges, promising practices, and keys to growing the underrepresented student populations in STEM fields in the United States and the United Kingdom. The collaboration characterized, compared, and contrasted US and UK approaches to effectively broadening / widening participation in STEM. To this end, the PMI2 CMU-UWE collaboration explored techniques, activities, approaches and resources that promise to be keys to growing the underrepresented student populations in STEM fields in the UK and the US. Interviews, observations, and literature searches lent credence to the following policy positions:

- Science, technology, engineering and mathematics (STEM) are critical drivers of economic growth in developed nations;
- STEM and its applications are vital to the prosperity in the UK and US;
- Patterns of aging, retirement, immigration, and demographic growth are altering the composition of the STEM labor force;
- The US and UK face critical STEM domestic skills gaps and intensifying global competition for STEM talent. Left unaddressed, this has the potential to wreak havoc on US & UK competitiveness and living standards;
- Broadening / widening participation of underrepresented groups in STEM fields are national imperatives of both nations;
- Both the US and UK have invested heavily in STEM education and workforce development. Promising practices have emerged that address issues from the entire student lifecycle of engagement, education, recruitment, retention, employability, and progression to graduate studies; and

- Universities have a special role to ensure that all students have access to rigorous STEM education and the opportunity to experience the thrill of scientific discovery.

The joint exploration revealed information upon which responses to the challenge of broadening / widening participation may be constructed for CMU and UWE in their respective environments:

- University–school partnerships can be powerful tools for early intervention and exposure to STEM matters. For example, INVESTING NOW- Class of 2011 (Swanson School of Engineering, University of Pittsburgh) represents the 18th pre-college cohort engaged in hands-on science experiences, career awareness and college planning seminars. Statistics for this group over time include 94% enrolled in college, 90% graduated with honors, 64% chose an engineering, mathematics or science major.
(http://www.engineering.pitt.edu/Diversity/Investing_Now/Content/Overview/);
- Early high-quality research experiences for undergraduates positively impact the student’s study and career trajectory;
- Historically Black Colleges and Universities (HBCUs) are potential partners for US and UK universities; and
- HBCU leadership holds unique expertise on effective practices that support the entire lifecycle of underrepresented students in STEM fields.

The US and UK share similar issues and agendas. The similarities and differences that emerge from each nation’s social and political histories enrich the multi-national conversation and open a pathway to fertile learning opportunities. US and UK universities are evenly matched partners in education, research, and industry.

In comparing and contrasting promising practices in the US and UK, the PMI2 CMU-UWE Team gained an enhanced understanding of:

- Barriers to participation and success in higher education (e.g. social, political, and process). During on-site visits in each country, factors such as lack of early exposure

to adult professionals in the STEM fields and lack of familiarity with the academic ladder to employment in STEM careers re-surfaced;

- Promising curriculum, enrichment and support structures for STEM studies;
- The impact of government mandated and funded widening participation (UK) versus foundation-driven funding without government mandates (US) impacts;
- Multiple approaches institutions can employ to effectively broaden participation in STEM; and
- National, local, and university broadening participation policies and programs.

PMI2 CMU-UWE Team members emerged equipped with new knowledge in designing and implementing broadening participation activities. New partnership opportunities for both CMU and UWE were highlighted. Carnegie Mellon's graduate-level collaboration with its partner in the west of England, Plymouth University, was strengthened.

PMI2 funding accomplished far more than simply providing time and transport for willing potential university partners to meet on home turfs to continue theoretical discussions of abstract concepts. Rather, this UK-subsidized experience has spurred the US partner to initiate action steps that further bolster its commitment to broadening participation in the STEM areas.

By the start of the 2012-13 school year, these CMU action steps were in place:

- Extending Access to Undergraduate Research Opportunities

Entering its 7th year of successful operation, the CMU Robotics Institute Summer Scholars Program (RISS) is a 10-week immersive research experience for undergraduate students. . Summer scholars have the opportunity to participate in state-of-the-art research projects, interact with a diverse research team, and to be mentored by leading faculty and technical staff. The program introduces aspiring students to research methods and helps them to build critical professional skills. Responding to a call for action in the realm of broadening participation, the

Robotics Institute's Summer Scholars program submitted a successful application to the National Science Foundation for program support that includes scholarship funds for underrepresented students.

- Innovative Graduate Education Collaboration

The American itinerary of the PMI2 CMU-UWE Team included an interview with Dr. Boyce Courtney Williams, senior vice president and chief of staff of NAFEO (National Association for Equal Opportunity in Higher Education). A significant point was driven home by Dr. Boyce during the meeting at this HBCU advocacy organization. As a national collective, HBCUs have adopted as part of their new millennium mission, the cultivation and expansion of new partnerships – both domestically and internationally. With that reassurance, the MS-RT program hosted the first in a series of conference calls with HBCU administrators representing Tennessee State University and Hampton University, focused on a potential graduate level collaboration. There's a mutual interest among these institutions to establish a strong foundation for graduating a competitive STEM workforce while building competitive, sustainable programming

- Global Exposure for Diverse Groups

Prior to the literature searches and learning visits that comprised PMI2 grant activities with the University of the West of England, Carnegie Mellon launched a dual award Master of Science degree in Robotics Technologies with Plymouth University. CMU and UoP are exploring the possibility of establishing a global summer program to immerse underrepresented students in robotics research and leadership development.

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APPENDIX

- Appendix 1 CMU team poster presentation at the 2011 Pennsylvania Council for International Education

- Appendix 2 CMU-UWE team poster presentation at the 2012 Going Global Conference

WIDENING PARTICIPATION IN THE UK and US: FINDING THE KEYS TO STUDENT GROWTH IN STEM FIELDS

Rachel Burcin and Angela Keiser, 2011

Carnegie Mellon University's Robotics Institute (Pittsburgh, USA) and the University of the West of England (Bristol, UK) are examining activities that expand underrepresented groups in higher education STEM studies.

Introduction

- Science, Technology, Engineering and Mathematics (STEM) are dominant engines of modern economic growth.
- National STEM workforce growth is almost twice as high as that of the total US workforce.
- Patterns of aging, retirement and immigration are likely to alter the composition of the STEM labor force.
- A shortage of students with STEM skills and low participation of underrepresented groups in STEM studies are critical issues in the United Kingdom and the United States.



The Study

The UK-US partnership is exploring activities targeting grades 6 – 20 in both countries which inhibit recruitment or promote retention of underrepresented populations in STEM studies.

Methods

1. Research Preparation and Planning
2. Assessing and Benchmarking
3. Networking and Sharing Best Practices
4. Dissemination

The UK-US team activities include:

- Teacher exchanges
- Meetings with education policy organizations
- Interactions with successful programs
- Site visits
- Dialogues with US Historically Black Colleges & Universities (HBCUs)
- Survey distributions
- Student focus groups
- Personal interviews with experts and stakeholders
- Professional literature searches

Anticipated Results

- Enhanced international curriculum, enrichment and support structures for STEM studies.
- Increased institutional understanding of how to address an urgent mutual challenge.

Discussion

- Why are the UK and the US investing in widening participation activities?
- What are examples of STEM widening participation activities in the UK & US?
- What's happening in your institution to bridge the gap between underrepresented student populations and STEM disciplines?
- Tell me more details about this UK-US study.

Keywords

Widening participation; diversity; inclusion; underrepresented populations, STEM

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WIDENING PARTICIPATION IN THE UK AND US: KEYS TO GROWING THE UNDERREPRESENTED STUDENT POPULATION IN STEM

Introduction

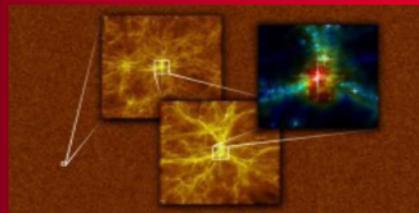
The University of the West of England (Bristol, UK) and the Master of Science in Robotics Technology (MS-RT) Program of Carnegie Mellon (Pittsburgh, USA) are exploring a shared concern: widening participation of underrepresented groups in science, technology, engineering, and mathematics (STEM) disciplines.

This collaboration:

- ▶ Examined issues at the secondary school, undergraduate and graduate levels that affect attraction, recruitment, retention and progression of underrepresented populations in STEM
- ▶ Compared and contrasted sample environments, mandates, funding, and approaches to widening participation in the United Kingdom and the United States

Background

- STEM disciplines are dominant engines of economic growth in developed countries like the UK and US
- National STEM workforces are projected to grow strongly in both the UK and US
- Patterns of aging, retirement and immigration are likely to alter the composition of the STEM labor force
- A shortage of students with STEM skills and low participation of underrepresented groups in STEM studies are critical barriers to growth and prosperity.



Methods

Sequentially:

- Research preparation and planning
- Assessing and benchmarking
- Networking and sharing best practices
- Dissemination

The UK-US team activities included:

- Identification and exploration of promising practices
- Site visits to education & policy organizations
- Dialogues with US Historically Black Colleges and Universities (HBCUs)
- Survey distributions
- Personal interviews with experts and stakeholders
- Literature reviews

Results

- Enhanced understanding of curriculum, enrichment and support structures for STEM studies
- Increased institutional understanding of how to address an urgent mutual challenge
- Government mandated and funded widening participation (UK) and foundation-driven funding without government mandates (US) impacts participation.

Discussion

- Why are the UK and the US investing in widening participation activities?
- What are examples of STEM widening participation activities in the UK and US?
- What's happening in your institution to bridge the gap between underrepresented student populations in STEM disciplines?

Findings

Possible areas for future exploration:

- Language of diversity
- Funding mechanisms
- Government interventions
- HBCU model

Funding and Support



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