INSTITUTIONAL CHANGE IN HIGHER EDUCATION: INNOVATION AND COLLABORATION

By

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> I remember 40 years ago in college when the dean said, "Look at the student to your left; now look at the student to your right; one of you will not graduate…." But [at UMBC] we say this "Look at the student to your left; look at the student to your right; our goal is to make sure all three of you graduate. If you don't, we fail, and we don't plan to fail."
> — Freeman A. Hrabowski, III, at UMBC's 2010 Convocation

> A surprising number of innovations fail not because of some fatal technological flaw or because the market isn't ready. They fail because responsibility to build these businesses is given to managers or organizations whose capabilities aren't up to the task. Corporate executives make this mistake because most often the very skills that propel an organization to succeed in sustaining circumstances systematically bungle the best ideas for disruptive growth.
> — Clayton M. Christensen, *The Innovator's Solution*

1. Visibility and challenges in higher education

American higher education is receiving unprecedented attention from the larger society, and it is also facing unprecedented challenges. The general public has become increasingly aware that America's global competitiveness depends on expanding access to higher education while increasing the success of those who enroll in colleges and universities. Recent years have seen a troubling trend as the country has slipped from its perch as world leader in the percentage of young people earning undergraduate degrees. Achieving a national goal of 55 percent of 25- to 34-year-olds with two- and four-year college degrees by 2020 will require the commitment of education, government and community leaders to see innovation at all levels of education, pre-kindergarten through college.

While increasing the total number of American college graduates is an important task, it is particularly important to the nation's prosperity and security that we focus on increasing the number of students completing degrees in science, technology, engineering and mathematics (STEM). We are seeing growing consensus about the key role that research and innovation will play in addressing global challenges involving healthcare, the environment, national security and the economy. Projected changes in the U.S. labor market reflect this consensus, with the areas of fastest growth expected in science and engineering. Supply has not kept pace with demand, leading government and business leaders to say they cannot find enough American workers with the skill and background in these STEM subjects to meet their needs. Only 6 percent of 24-year-olds in the United States have earned a first degree in the natural sciences or engineering, placing the country 20th in a comparison group of 24 countries.[i] The National Academies 2005 *Rising Above the Gathering Storm* report noted this and other troubling statistics as it called for increased funding for research and improvements in STEM education and teacher training. Though the report received wide attention and progress was made in some areas, a 2010 follow-up report noted that the outlook has worsened and the storm is "Rapidly approaching category 5."[ii]

Many companies and research institutions look abroad to make up for the inadequate supply of U.S. students and workers with the necessary skills. Indeed, students from China, India and other countries account for almost all of the growth in STEM doctorates awarded in the U.S. over the past 15 years. However, many of these students eventually return to their own countries, taking their talents with them. We can expect this trend to continue as the economies in many developing countries grow stronger.

To address the shortage of Americans with STEM degrees, colleges and universities will need to pay particular attention to groups that have been underrepresented in these fields, including minorities, women, and students from low-income backgrounds. In 2007, according to a recent National Academies report on underrepresentation, African Americans, Native Americans and Alaska Natives, and Hispanics and Latinos comprised nearly 40 percent of K-12 public school enrollment, but only 26 percent of the country's undergraduate enrollment and 18 percent of those earning science and engineering bachelor's degrees.[iii] The Higher Education Research Institute at the University of California Los Angeles has released data showing that between 30 and 35 percent of students from these groups begin their undergraduate studies aspiring to complete majors in these subjects, a rate that is equivalent to that of white and Asian American students.[iv] The 5-year completion rates in STEM fields is low for all races, but it is particularly low for students from these underrepresented groups. Only 33 percent of white students and 42 percent of Asian American students who enter college or university aspiring to major in a STEM subject complete STEM degrees within five years of college entry, compared to 22 percent of Latino students, 18 percent of black students, and 19 percent of Native American students.

None of these challenges can be solved easily. However, American colleges and universities must contend with each, even as they face major fiscal hurdles because of diminished resources available to governments and families.

2. Colleges and universities must establish priorities and change culture

Institutions that will be successful in addressing these challenges will need to establish priorities, focus on strategic planning, and emphasize effectiveness and efficiency in the use of resources. In many cases, success will require culture changes within institutions as part of the planning and budgeting processes. Universities will need to decide which activities they will continue supporting and which they will eliminate.

Changing culture involves careful self-reflection, robust dialogue and rigorous analysis. At UMBC, when we think about the culture of an institution, we think about our values, our practices, our habits, and even the relationships among faculty, staff and students. Culture shapes the University's vision as an entire institution and the vision we have for ourselves. In some cases, culture can make problems seem intractable. If, for example, the culture of an institution suggests that student retention is primarily a staff responsibility, then faculty may rarely become involved with this challenge beyond fulfilling their classroom responsibilities. Similarly, the culture of some institutions holds that if minority students are not succeeding, minority staff members or staff working in minority programs should be held responsible for improving performance.

My colleagues at UMBC have made it a priority to strengthen and improve graduation and retention rates on campus, while also improving the performance of students in STEM fields and encouraging the success of minorities in these areas. We have changed the culture of the institution to accomplish these tasks. For example, until recent years, the faculty considered broad retention issues or the general academic performance of particular groups in STEM fields to be administrative and staff responsibilities. Generally, faculty considered themselves responsible for working with individual students in particular classes. However, it became clear that to make progress in this and other areas, we needed to encourage the involvement of the entire campus, including faculty and students, in understanding and addressing each challenge.

Culture change at UMBC started most notably with the development of the Meyerhoff Scholars Program for minority STEM students in 1989. The program provides students with financial, academic and social support while encouraging collaboration, close relationships with faculty and immersion in research. Over the past two decades, the program has been recognized as a national model for preparing research scientists and engineers, and UMBC has become the nation's leading predominantly white institution for producing African-American bachelor's degree graduates who go on to complete STEM Ph.D.'s. The program has also served as a catalyst for change across campus, leading to special scholars programs for high-achieving undergraduates of all races in the arts, humanities, public affairs and STEM teaching.

The importance of focusing on group study and other lessons from the Meyerhoff Program informed course redesigns for first-year courses in chemistry, psychology, and other disciplines. Faculty in the chemistry department developed a Chemistry Discovery Center that is now a central part of introductory classes. Students attend weekly two-hour sessions in this center, working in four-member teams as they explore and develop key concepts. Since the center opened in 2005, pass rates in introductory classes have risen dramatically, and the number of students majoring in chemistry has increased by 70 percent, while the number of biochemistry majors has increased by 42 percent.

Other lessons from the Meyerhoff Program have helped us address additional issues we have faced on campus, e.g. the underrepresentation of women in science and engineering. For one thing, it taught us the need to move away from conclusions based on anecdotal information. Because people saw women in science and engineering departments, they thought we did not have a problem with underrepresentation. And yet, when we analyzed the data, we found that many of the women there were either graduate students or were faculty in non tenure-track positions such as lecturer or instructor. It was only through the systematic analysis of data that we were able to make progress in this area.

Similarly, at the graduate level, when we said to the engineering faculty that half of the Ph.D. students were not graduating, one highly respected faculty member commented, “That couldn’t be true. Every Ph.D. student I know has graduated.” That was the problem. Students known well by the faculty were indeed graduating. Unfortunately, a number of graduate students had not developed strong relationships with faculty and subsequently left the program.

UMBC has been recognized widely as a leader in higher education innovation. For two years in a row, the university has been rated no. 1 in the nation among up-and-coming national universities by the *U.S. News & World Report America’s Best Colleges Guide*. The success of both the Meyerhoff Scholars Program and course redesigns in chemistry has been reported in the journal *SCIENCE* and other publications. Innovation has spread across campus. For example, with funding from the Kauffman Foundation, UMBC has strengthened its programs through the Alex. Brown Center for Entrepreneurship. A number of the entrepreneurs who got their start through the Alex. Brown Center have established companies at the bwtech@UMBC Research and Technology Park. This park, located adjacent to campus, has become a regional hub for economic development, with more than 90 early stage and established companies developing technology and offering support services in the life sciences, clean energy and cybersecurity.

Several companies at bwtech, and dozens more in Maryland, are run by women CEOs who graduated from the NSF-funded ACTiVATE program. This year-long program was developed at UMBC to increase the number of women succeeding as entrepreneurs and corporate leaders. It gives mid-career women training and support as they build new companies based on inventions from the region's research institutions and federal laboratories. Through a licensing agreement with the Path Forward Center for Innovation, the program's proven methodology is being offered to a growing audience, with classes offered in Texas, Virginia, and Michigan, and plans for expansion in other states. A grant from NSF's Partnerships for Innovation Program helped establish a modified version of the program in Montgomery County, Md. — home to the National Institutes of Health — for men and women completing post-doctoral research in the life sciences.

The roots of all this activity at UMBC go back to the establishment of the Meyerhoff Scholars Program. Based on the success of the Meyerhoff model, we have proposed a social transformation theory of change. The theory has several components, including (1) the development of empowering settings for minority student achievement, (2) larger institutional change processes, and (3) assessment and evaluation. The change process focuses on a strategic approach to ensure successful implementation and sustainability over time. This process requires (1) senior leadership, (2) the development of institutional vision and promotion of buy-in, (3) the capacity necessary for transformation and maintaining change, and (4) leveraging resources. The following analysis provides a careful look at some of the initiatives that have applied this theory to change the culture of the university.[v]

3. UMBC is focused on societal issues in light of demographic changes

An increasing number of Americans have completed college degrees in recent decades.[vi] Between 1947 and 2005, the percentage of whites 25 and older with college degrees increased from six to 28 percent, and the percentage of African Americans the same age with college degrees rose from just three percent to 18 percent. The percentage of Hispanic Americans 25 and older with college degrees has doubled to 12 percent in the past three decades, and more than 50 percent of Asian Americans in the same group now have degrees. (Unfortunately, the educational attainment data on Native Americans have not been reported because the samples are too small.) Despite these gains, the percentage of Americans 25 and older with college degrees is less than 30 percent. In contrast, it is estimated that in fewer than 20 years, by 2025, in such countries as South Korea, Japan and Canada, more than half of the adults (55 percent) will be college-educated.[vii]

Increasing the number of American college graduates will be especially challenging in light of the changing demographics in the nation. Within the next several decades, one of every two Americans will be of color. While the black and white populations are not increasing substantially, one in every four Americans will be Hispanic, and the Asian population will grow from 5 percent to 10 percent. Many of the black and Hispanic children, in particular, are from families that have not necessarily emphasized the importance of academic skills development. In addition, more public schools are becoming "majority minority" each year — that is, minority students becoming the majority. With increased diversity, colleges and universities are having to focus more resources than ever on professional development for faculty and staff to be effective in working with these students. Responding to these changes is a challenge for institutions and for individuals, and it becomes important that professionals examine their own attitudes, just as institutions must examine their policies and practices, to ensure that universities are both welcoming and supportive of these students. In addition, about 2 million people migrate to the United States each year. About half lack English language skills.[viii] We will see colleges and universities expecting professionals and students to become more sensitive to cultural differences and devoting more effort to combining English-as-a-second-language initiatives with academic-skills development. The goal, of course, will be to ensure that many more immigrants become educated and productive in the workforce.

4. Increasing access and success

Announcing the American Graduation Initiative in 2009, President Obama called for the United States to again lead the world by having the highest proportion of college graduates by 2020. The President was responding in part to data showing a pattern of underachievement at all levels. For every 100 ninth-graders, only about 68 graduate from high school in four years, and only 18 complete a two-year degree within three years or a four-year degree within six years.[ix] Despite the fact that the percentage of Americans attending college and earning degrees is gradually increasing, the rate of increase is far lower than what has been achieved in other countries.[x] Many countries have already caught up with or surpassed the United States in the percentage of college graduates. According to the OECD's 2010 *Education at a Glance* report, America is now third in the world among the organization's 34 member countries in the percentage 25- to 64-year-olds with two-year or four-year college degrees (41 percent).[xi] Canada and Japan now lead in this category, with 49 and 43 percent of residents in this group, respectively, holding these degrees. The rapid growth in higher education in other countries becomes more apparent when looking at younger age groups. The United States is eighth among 25- to 34-year-olds (42 percent of Americans in this category hold postsecondary degrees), putting the country behind Korea (58 percent), Canada (56 percent), Japan (53 percent) and four other countries (and also in a tie with Australia and Belgium). After decades of sustained improvement leading up to the middle of the twentieth century, the United States can no longer claim that each generation of Americans will be better educated than the one before.

As mentioned earlier, if the U.S. is to continue competing globally, American colleges and universities must increase both access and success, ensuring that the admissions door is not a revolving door. Currently, there are millions of Americans in the workforce who started college but did not graduate. The college board estimates that only slightly more than half of students who begin work on a bachelor's degree complete their studies within six years, and the completion rate is significantly lower for underrepresented minority students.[xii] The institutions that have had the greatest success retaining and graduating students have created a climate that encourages (1) open communication about key questions, (2) honesty about strengths and challenges, and (3) the development of innovative strategies and initiatives that focus on particular problems (including programs that encourage students to connect with each other and with members of the faculty and staff). Important questions include: How well do we know our students? Have we moved beyond their test scores and grades to learn about their backgrounds and aspirations, their interests, and the challenges they face? Have we used the data to examine particular groups based on such factors as gender, race, major, socioeconomic background, and level of high school preparation? Have we identified those faculty and staff who have demonstrated records of supporting students? Have we pinpointed and highlighted those practices that have been most effective in helping students succeed? Do we know why students discontinue their studies? What proportion leave because of inadequate funding, poor academic performance, dissatisfaction with the campus climate, or interest in majors not offered by the institution? Do we conduct follow-up interviews with students who have left, and if so, what have we learned?

Technology is playing an increasingly important role in extending the reach of higher education, helping institutions determine which students to admit and what support they need. More important, technology is helping improve how faculty teach, students learn, and institutions do business. At UMBC, we are using technology to learn about students and track their progress. We use analytics to help shape our students' experiences, starting with their admission to the university and continuing with their post-graduate placements. Using technology, we have been pinpointing characteristics of students that help us both identify academic challenges and develop strategies to address those challenges. We're also using our Blackboard course management system to augment, reinforce, and analyze learning in the classroom. The ability to take action based on what we learn about students' performance — for example, conducting "real-time" academic interventions with students before poor course performance becomes an insurmountable problem — is essential.

5. Problem particularly challenging in STEM fields

Beyond the culture of each college and university campus, we in American society often talk about math and science being "hard," and we too often suggest that few people have the skill to excel in these subjects. In addition, negative stereotypes of scientists and engineers permeate popular culture, regularly showing up on television shows and in movies. Those students still attracted to the possibility of a career in science or engineering often begin their undergraduate studies on campuses where large numbers of students fail or do poorly in introductory STEM classes.

Perhaps it is no surprise, then, that the 5-year degree completion rate is dramatically lower for STEM majors than it is for students in other fields. The Higher Education Research Institute, analyzing data from a sample of about 200,000 students who started at four-year colleges and universities in 2004, reports that three-quarters of white students who started in non-STEM fields graduated within five years, compared to a five-year completion rate of only 56 for white students who started in STEM subjects (this 56 percent includes students who completed degrees in both STEM and non-STEM subjects).[xiii] Asian American students starting in STEM and non-STEM subjects fared slightly better in each case, but the same disparity exists. The differences are even greater for Latino, Black and Native American students. Starting in non-STEM subjects, about 60 percent of these students go on to complete degrees within five years (Latino students do slightly better, with 68 percent completing a degree within five years). Starting in STEM subjects, however, only 40 percent of Latino students, 31 percent of Black students and 37 percent of Native American students go on to complete degrees in any major within five years. (The fact that many students starting in STEM subjects switch to other majors accounts for the lower 5-year STEM completion rates mentioned earlier in this paper.) This highlights a disturbing fact: Not only did the students who started in STEM fields complete STEM majors less often than their non-STEM peers, but far fewer students who aspire to major in STEM fields completed *any* degree in five years.

6. It takes researchers to produce researchers: Meyerhoff Scholars Program

Over the past 23 years, the Meyerhoff Scholars Program at UMBC has graduated hundreds of underrepresented minority students, most of whom have gone on either to complete STEM Ph.D.'s (or M.D./Ph.D.'s) or to pursue STEM postgraduate degrees. These graduates, including some who hold faculty positions at top universities, are emerging as leaders in their disciplines. In addition, retention and graduation rates for underrepresented minority students (including students not in the Meyerhoff Program) equal our rates for all students at UMBC, both in STEM fields and across all disciplines.[xiv]

Our goal in creating the program was to develop a comprehensive, research-based initiative focused on specific factors associated with minority student success in STEM subjects, including knowledge and skill development, academic and social integration, support and motivation, and advising and monitoring.[xv] The process of cultural change that the Meyerhoff Program brought to our campus started with focus-group discussions involving students, faculty, and staff concentrating on minority-student underachievement. Although institutional culture reflects subjective values, cultural change requires rigorous analysis, both qualitative and quantitative, making these inclusive conversations essential. Change begins when an institution looks carefully at itself, identifies its strengths and weaknesses, recognizes the challenges it faces, and understands how its response to those challenges can lead to desired outcomes.

The components of the Meyerhoff Scholars Program reflect what we learned from our campus conversations and from research into other programs across the country. Twelve key components of the program include (1) recruiting top minority students in math and science, (2) a summer bridge program, (3) comprehensive merit scholarship support, (4) active faculty involvement in recruiting, teaching and students' research experiences, (5) strong programmatic values including high achievement, study groups, tutoring and preparing for graduate or professional schools, (6) substantive research experiences for students, (7) intensive academic advising, (8) active involvement of the entire campus, (9) linking students with mentors, (10) a strong sense of community among the students, (11) communication with students' families, and (12) continuous evaluation and documentation of program outcomes.[xvi]

More broadly, we also encouraged minority students to study in groups; strengthened tutorial centers; encouraged faculty to give these students feedback earlier in the semester; emphasized the need for faculty and staff members to communicate with incoming students about the demands they would face in STEM fields; and focused on supporting students during their crucial freshman year.

For more than two decades, we have tried to create a community of student scholars who not only work together in labs and form study groups to master coursework, but who also consult closely with faculty and staff who understand and appreciate the important roles they play in supporting these aspiring young scientists and engineers. The success of the program, which is supported by the Baltimore philanthropist Robert Meyerhoff, also illustrates the essential role that philanthropic support and partnerships with donors must play in higher education's efforts to address broad societal challenges.

Regular assessments have been invaluable as well. From the start, the program's strengths, weaknesses, and outcomes have been rigorously assessed by teams of independent experts. In these evaluations, there has been no substitute for specificity—knowing how individual students and groups of students are performing in specific classes and majors. We have learned, for example, that we need to examine different groups based on such factors as gender, race, major, socioeconomic background, level of high-school preparation, and college performance. Documenting successes has helped build momentum, and, perhaps more important, documenting challenges and responding to them have demonstrated a commitment to substantive improvement.

Such thorough and honest evaluations have been instrumental in building campus support for the Meyerhoff program and for broader change in the institution's culture. As mentioned earlier, the program has served as a model for developing other campus programs focused on academic excellence and inclusion, broadly defined.

7. Focus on societal problems/Course redesigns/success in introductory classes

Our success with the Meyerhoff Program has motivated broader curricular and pedagogical initiatives. In chemistry, our faculty members redesigned the curriculum in first-year courses to increase active learning through collaborative interactions. Central to this redesign was the development of the Chemistry Discovery Center. Student attend this center for two-hour weekly "discovery learning" sessions in which they work in groups of four on worksheets crafted to guide them in the development of central ideas and principles. In their groups, students rotate through such roles as supervisor, recorder and communicator. Instructors in discovery sessions act as facilitators, guiding students as they develop theories and solve problems.

The results since the Discovery Center opened in 2005 have been striking. The "C or better" pass rate in Chemistry 101 has risen from 61 percent to 85 percent, and the same rate in Chemistry 102 has increased from 73 percent to almost 80 percent. At the same time, more students in both classes are earning A's and B's. More important, the number of chemistry majors has risen by 70 percent in five years, and the number of biochemistry majors has increased by 42 percent. In other disciplines at UMBC, including psychology, similar efforts relying on group study and collaboration, technology, and active learning have also yielded positive results, including higher retention and grades and increased coverage of content during the semester. (Such course-redesign efforts are part of an overall effort to improve academic outcomes in challenging introductory courses at the University System of Maryland.)

Building on lessons learned in chemistry, we opened a new facility in 2010 to encourage active learning and collaboration in physics, mathematics and biology as these departments redesign their introductory classes. The facility — called CASTLE, for CNMS (College of Natural and Mathematical Sciences) Active Science Teaching and Learning Environment — uses technology and draws on the latest research about group dynamics to create a space that encourages collaboration and active learning as students solve problems and engage with key concepts. Working in three-member groups, students sit at color-coded chairs that can be used to assign and vary individual responsibilities. Each group has access to a computer, but the tables are designed so that screens can be locked downward when they are not in use. Each table holds two or three of the smaller groups, giving instructors the option of working with varying numbers of students when providing guidance or feedback. To make the most effective use of the facility, the college is providing ongoing training and support to encourage the development of novel and innovative instructional approaches.

As departments develop new approaches and tools, it is essential that we continually assess what works and what does not, making adjustments where necessary. With funding from the National Science Foundation, we are now assessing the impact that an active learning approach and various types of support have on first-year aspiring STEM majors. As part of the iCubed Project — an abbreviation for "Evaluation, Integration, and Institutionalization of Initiatives to Enhance STEM Student Success" — eligible first-year students who agree to participate in the study will be randomly assigned to one of four different treatments: (1) community-based study groups; (2) pro-active mentoring with ongoing retention risk assessment and high-status faculty intervention; (3) pro-active mentoring with ongoing retention risk assessment and staff intervention; and (4) active learning in one of three introductory mathematics courses. (Since Meyerhoff students and those participating in one of UMBC's five other scholars programs already receive many of these types of support, they are not eligible to participate in the study.) The strength of the iCubed study design will enable us to answer central questions about the instructional approaches and support services that most effectively increase the probability that a first-year student aspiring to major in a STEM subject will achieve that goal.

UMBC is also one of four universities participating in the Howard Hughes Medical Institute's National Experiment in Undergraduate Science Education, or NEXUS Project. The goal of this project is to develop and share effective approaches for teaching interdisciplinary science. UMBC will focus on the development of course modules that bring mathematical modeling into introductory biology. The modules will be designed so they can be used at other institutions, and a key element will be the identification of a set of competencies for assessing whether students have mastered the material.

8. Changes in graduate programs

The success of the Meyerhoff Scholars Program, the implementation of broad efforts to increase student success in STEM subjects, and the development of programs to create a welcoming and supportive atmosphere across campus have all transformed the climate at UMBC for undergraduate studies. With these successes, along with dramatic changes in individual departments, one would think graduate programs in the same departments would also experience increases in the number of minority students succeeding. The lesson, however, has been that to make progress in any area, the institution has to be willing to devote adequate resources to both understand and address the specific problem.

At the graduate level, UMBC has developed a number of programs focused on increasing both access and success, including two major STEM initiatives with funding from separate federal agencies, the National Institutes of Health and the National Science Foundation. The NIH-funded Meyerhoff Graduate Fellows Program in biomedical science and engineering, created in 1996, mirrors the undergraduate Meyerhoff Program, offering financial, academic, social and professional support to minorities, as well as to non-minorities interested in the advancement of underrepresented minorities in the sciences. Key components of the program include a summer biomedical training program, regular group social activities, monthly student seminars, instruction on technical writing and applying for grants, and financial support for student travel to minority-scientist seminars. Before it started, no underrepresented minorities were enrolled in UMBC's biology or biochemistry programs. Now, there are 12 Meyerhoff fellows in the biology program and 14 in biochemistry (a joint program with the University of Maryland, Baltimore [UMB]). In all, the program supports 44 graduate students at UMBC in biology, chemistry, biochemistry, psychology, engineering, and physics, along with 22 at UMB in molecular medicine, epidemiology and other programs.

Another program focused on producing broader changes to increase the diversity in STEM Ph.D. graduates is the PROMISE Program: Maryland's Alliance for Graduate Education and the Professoriate, an initiative funded by the NSF's Alliance for Graduate Education and the Professoriate (AGEP) program involving Maryland's three public research universities. This program supports the development and implementation of innovative approaches for recruiting, mentoring and retaining minority doctoral students, and it also calls for the development of strategies to identify and support underrepresented minorities considering academic careers. The results of both these programs have been stunning. In fact, the number of underrepresented minority STEM Ph.D.s produced has risen from 1 in 1997 to 9 in 2010.

Drawing on lessons from these initiatives and other programs, UMBC, in partnership with the Council of Graduate Schools (CGS), is examining issues of doctoral completion and attrition in STEM fields, humanities and social sciences through the Ph.D. Completion Project. Based on insight gained through this effort, my colleagues wrote *The University as Mentor: Lessons Learned from UMBC Inclusiveness Initiatives*.[xvii] They identify 10 lessons that contribute to institutional change by enhancing relationships between students and faculty mentors, clarifying the role of graduate education within the campus community, and changing the university culture experienced by graduate students. These lessons are targeted at two major national challenges that are similar to those facing colleges and universities at the undergraduate level: (1) the country needs to increase the number of domestic students — particularly women and underrepresented minorities — who obtain doctoral degrees and move into careers in STEM fields; and (2) we need to reduce the drop-out rate of doctoral students, particularly among underrepresented groups.

Challenges at the graduate level, particularly in STEM fields, reflect ongoing struggles in K-12 education and at the undergraduate level. However, it is clear that success in graduate programs can have added benefit by providing role models for younger students. If we expect more young people to pursue STEM Ph.D.s, they will need to see more research scientists who look like themselves.

The 10 key lessons learned at UMBC in the area of graduate education are similar to those we have learned at the undergraduate level. In general, universities must create a welcoming environment for prospective students while building a supportive community that encourages professional development for current students. Specifically, we learned that transformation requires (1) Interest and support from campus leaders; (2) faculty and staff engagement in creating a supportive environment; (3) effective recruitment strategies; (4) a strong mentoring system; (5) ongoing data collection and analysis; effective support including (6) orientation, (7) financial support, and (8) regular and ongoing recognition of success and progress; (9) programs and services aimed at supporting underrepresented minority and women doctoral students; and (10) a focus on preparing students for careers after graduate school.

9. Supporting women – ADVANCE Program

People often ask me why I'm the principle investigator for UMBC's ADVANCE program, an NSF-funded initiative aimed at increasing the representation and advancement of women in academic STEM careers. I respond by explaining that men must be engaged in these efforts because the continued underrepresentation of women in these fields is a critical American issue. This reflects the approach we have taken to change the University's culture: Faculty and staff of all races need to take ownership of these issues so we can develop solutions to these difficult problems.[xviii]

Through the ADVANCE program, we have developed mentoring initiatives to both increase the participation of women faculty in STEM fields and to advance them through the faculty ranks and into leadership positions. This comprehensive "university as mentor" approach is designed to embed focused, continuous support of women scientists at all levels — undergraduate and graduate students and faculty — into the fabric and foundation of the university's culture.

The paucity of women faculty in STEM fields is a long-standing national problem. A 2005 study shows that women faculty in the top 50 research universities are underrepresented at all ranks, especially as full professors. The study also reveals that underrepresented minority women "are almost non-existent in science and engineering departments at research universities" and are less likely than Caucasian women, or men of any race, to be awarded tenure or reach full professor status.[xix] The UMBC ADVANCE Program uses a comprehensive approach based on lessons learned in producing minority scientists to meet these challenges. Our framework includes (1) developing, revising, and institutionalizing policies and practices, and allocating resources, in ways that support the recruitment, hiring, and advancement of women – including particularly minority women – for the faculty at all ranks; (2) engaging the campus broadly in ongoing discussions, informal and formal, that address issues of racial and gender diversity in STEM fields; and (3) establishing a system of targeted mentoring programs designed to create a clear and understandable pathway for STEM women to achieve tenure and promotion, and to transition to academic leadership positions at the university.

The program started in fall 2003, and the number of female tenure-track STEM faculty increased nearly 50 percent in the next four years from 29 to 43, greatly exceeding the 4 percent increase in male tenure-track faculty over the same period (137 to 142). In 2003, women only accounted for 12 percent of UMBC's tenured and tenure-track faculty. Now, women hold 36 percent of these positions, and they account for 51 percent of the university's assistant professors.

One successful strategy for developing a culture of inclusion for women faculty has been a campus-wide Distinguished Speaker Series, spotlighting the contributions of top women research scientists and focusing on issues that women faculty in STEM face in the academy. We also held regular meetings with key groups to focus on progress and challenges. Departments conducting faculty searches are required to submit written Faculty Diversity Recruitment Plans and participate in annual training on diversity recruitment presented by the Provost's office. Female candidates for STEM faculty positions meet with faculty from WISE (our chapter of Women in Science and Engineering) and with representatives of the ADVANCE Program to make them aware of the resources and support available.

Through these and other efforts, we learned a great deal about some of the special challenges women in STEM fields face, particularly minority women, because of the numerous campus and community demands that are made on their time. Maintaining a productive research agenda is one such challenge, and to avoid attrition of minority women from doctoral programs and academic positions, institutions need to be supportive of these promising scholars and help to protect their research agendas as they move toward either completing their doctorates or achieving promotion and tenure.

10. Institutional Change

As we have seen, the success of the Meyerhoff Scholars Program at UMBC led to other major initiatives, including a range of scholars programs for students of different interests, curriculum changes in first-year STEM courses, and initiatives focused on graduate student success and the diversification of the faculty. Through these efforts, we have been able to change the campus culture and build community for undergraduates, graduate students and even faculty.

Equally important, the lessons learned through these initiatives have led over the past decade to an emphasis on academic innovation in a variety of areas. We have shown that the framework for institutional change that we developed with the Meyerhoff Program can be applied to a broad range of difficult challenges. We hope that aspects of this framework can serve as a useful guide for other institutions as they make cultural changes to meet these challenges and address societal problems.

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[i] National Academies, *Rising Above the Gathering Storm: Energizing and Employing America for a Brighter Future.* Washington, DC; National Academies Press, 2007. Fig. 3-16B.
[ii] National Academies, *Rising Above the Gathering Storm, Revisited: Rapidly Approaching Category 5.* Washington, DC; National Academies Press, 2010.
[iii] National Academies, *Expanding Underrepresented Minority Representation: America's Science and Technology Talent at the Crossroads.* Washington, DC; National Academies Press, 2010.
[iv] Higher Education Research Institute at UCLA, "Degrees of Success: Bachelor's Degree Completion Rates Among Initial STEM Majors," HERI Report Brief, January 2010.

[v] Maton, K.I., Hrabowski, F.A., Ozdemir, M., and Wimms, H., "Enhancing Representation, Retention, and Achievement of Minority Students in Higher Education: A Social Transformation Theory of Change," *Toward Positive Youth Development: Transforming Schools and Communities*, ed. Shinn, M., and Yoshikawa, H., Oxford University Press, 2008.
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[ix] This section draws on a piece I wrote with Jack Suess, UMBC's Vice President for Information Technology: "Reclaiming the Lead: Higher Education's Future and the Implications for Technology," *EDUCAUSE Review,* vol. 45, no. 6 (November/December 2010).
[x] Indicator A1, table A1.4. Organisation for Economic Cooperation and Development, *Education at a Glance 2010: OECD Indicators.* July, 2010. Accessed at www.oecd.org/edu/eag2010.
[xi] Indicator A1, table A1.3A. *Education at a Glance 2010: OECD Indicators.*
[xii] The College Board's estimates for six-year completion rates are: 56 percent for all students; 39 percent for Native American students/Alaska Natives; 41 percent for African American students; and 47 percent for Latino students. Data from Lee, J.M. and Rawls, A., *The College Completion Agenda: 2010 Progress Report,* The College Board Advocacy and Policy Center. Accessed at completionagenda.collegeboard.org.
[xiii] Higher Education Research Institute at UCLA, "Degrees of Success: Bachelor's Degree Completion Rates Among Initial STEM Majors."
[xiv] This section draws from: Hirshman, E., and Hrabowski, F.A., "Meet Societal Challenges by Changing the Culture on Campus," *The Chronicle of Higher Education*, Jan. 16, 2011.
[xv] Maton, K.I., Hrabowski, F.A., Ozdemir, M., and Wimms, H., "Enhancing Representation, Retention, and Achievement of Minority Students in Higher Education: A Social Transformation Theory of Change," *Toward Positive Youth Development: Transforming Schools and Communities*.
[xvi] These 12 components are presented in multiple publications. The list here is from: Hrabowski, F.A., "Leadership for a New Age: Higher Education's Role in Producing Minority Leaders," *Liberal Education*, Spring, 2004.
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