Model Institutions for *Excellence*

A MODEL OF SUCCESS—

THE MODEL INSTITUTIONS FOR EXCELLENCE PROGRAM'S SUCCESSFUL LEADERSHIP IN STEM EDUCATION (1995–2007)

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Alliance for Equity in Higher Education
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Acknowledgments

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Disclaimer
Any opinions, findings and conclusions or recommendations expressed in this report are those of the authors and do not necessarily represent the official views, opinions or policy of the National Science Foundation.

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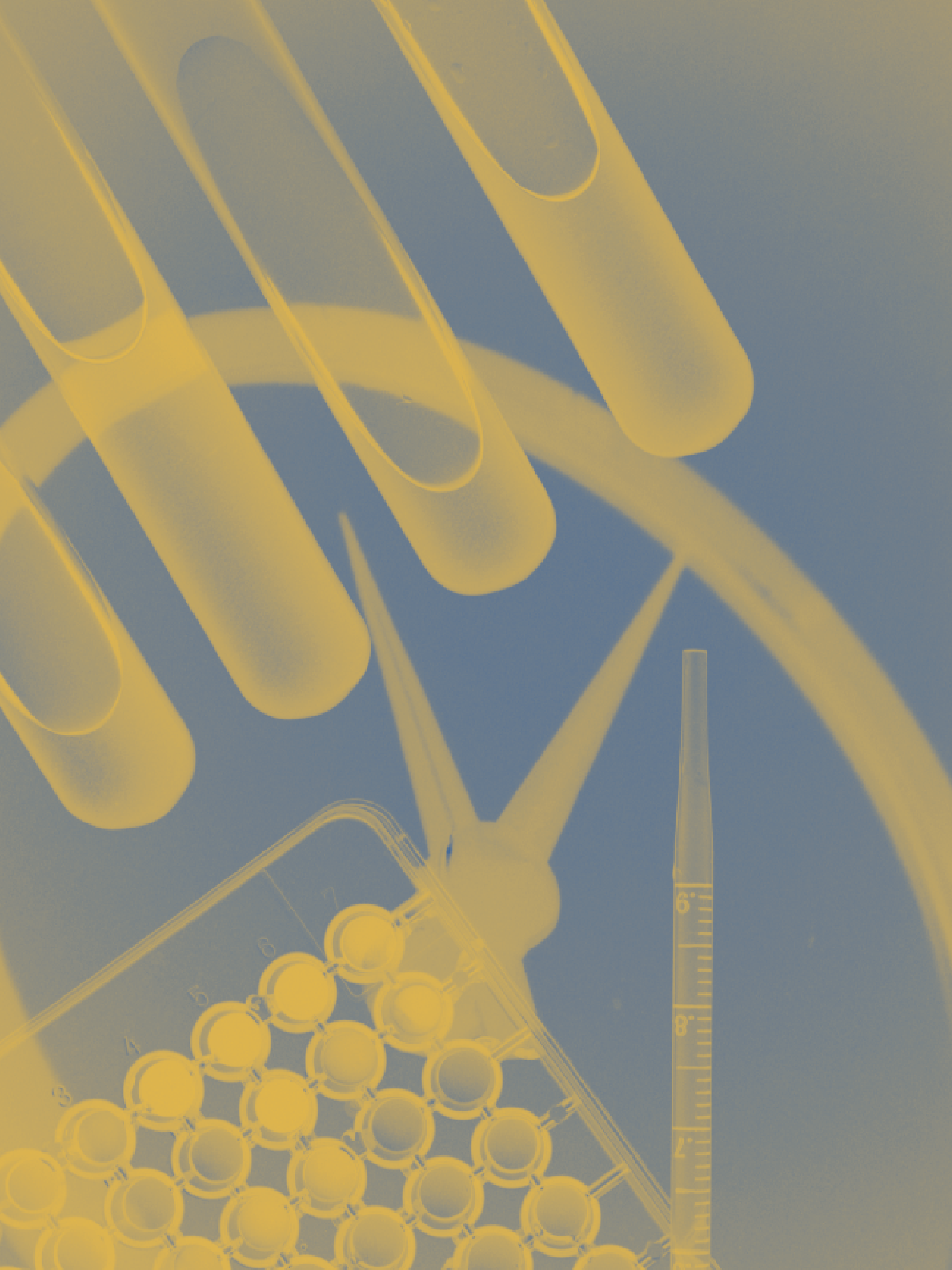

Executive Summary

The Model Institutions for Excellence (MIE) program represents an 11-year-long investment by the National Science Foundation (NSF) and the National Aeronautics and Space Administration (NASA) to increase graduates in the science, technology, engineering, and mathematics (STEM) fields. Working with Historically Black Colleges and Universities (HBCUs), Hispanic-Serving Institutions, and Tribal Colleges and Universities, MIE has built the capacity of minority-serving institutions (MSIs) to increase the STEM workforce as well as bolster diversity within STEM professions. To further expand the MIE work, staff at the Institute for Higher Education Policy (IHEP) contributed new data and analysis.

At a time where exemplary STEM education has been deemed more crucial than ever to progress, security, and economic viability domestically and internationally, the long history of experience and success in educating the next generation of STEM graduates makes the MIE program a valuable resource. This report offers a brief summary and outlines the strategies, impacts, and lessons learned through the MIE program to ultimately produce a replicable model for other institutions of higher education and synthesize larger policy recommendations. It should also offer a standard of investment for MSIs and other institutions with significant minority student populations.

MIE: The Need

Indicators of workforce shortages in the STEM fields, concerns about economic competitiveness relative to other countries, and a focus on the development of STEM workforce representatives within the U.S. population reveal the quantitative, qualitative, and diversity motivations behind the MIE program. As early at 1985, reports warned of a potential dearth of trained professionals in the STEM fields. Other statistical data revealed major achievement gaps in STEM success among black, Native American, and Hispanic students as compared to their white counterparts.

MIE: Conception

In 1993, when the MIE program was conceived by Morehouse College President Walter Massey, and later supported by the National Science Board, he was contemplating what would happen if STET institutions provided the same supportive environments for STEM education that he found at Morehouse. This HBCU in Atlanta gained its prominence as one of many MSIs that lead the nation in educating students of color, despite challenges they face, such as historically under-funded programs and racially disparate preparation at the secondary school level.

Massey worked with NSF staff to identify institutions to participate in the innovative initiative. The MIE sites ultimately selected, and at present, include Bowie State University (MD), the Oyate Consortium [composed of Oglala Lakota, Sisseton-Wapheton, and Sitting Bull Colleges] (SD), Spelman College (GA), Universidad Metropolitana (Puerto Rico), University of Texas at El Paso, and Xavier University (LA). These institutions had to consider strategies concerning faculty training, appropriate scholarship levels, academic support, tools needed for advanced research, and other institutional mechanisms responsible for STEM student production.

MIE programs at each institution concentrated on a range of strategies, such as innovative recruitment and retention, counseling, and academic enrichment. The full range of MIE strategies is presented below (American Institutes of Research 2005).

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While 2006 caps the end of the MIE funding cycle, the MIE institutions' commitment to the mission continues. Each grantee has been engaged in institutionalization efforts to foster sustainability and permeation of MIE strategies. The MIE Principal Investigators, designated institution staff, have also been assisting other minority-serving institutions who are interested in replicating their successful models. By presenting the strategies as an aggregate MIE model at regional and national conferences, they have been disseminating what are now tested approaches to STEM education. The central purpose of this report includes disseminating the new knowledge MIE has generated.

The MIE Model

- *Recruitment and Transition Initiatives:*
  Prepare matriculating students to succeed in college and to introduce STEM disciplines and careers by:
  - Training elementary, middle, and high-school teachers to improve their content knowledge and teaching ability;
  - Introducing young students to the STEM world through hands-on activities (e.g., science fairs, or Geographic Information Systems mapping); and
  - Bridging the transition from high school or community college into college or university (e.g., summer orientation programs).

- *Student Support:*
  Provide social, financial, and academic assistance to students by:
  - Supporting peer and teacher/student mentoring programs;
  - Tutoring;
  - Providing and advising students on opportunities for financial aid;
  - Starting each course at the point at which most students have sufficient background to understand basic concepts;
  - Scheduling "cohort" programs in which a small group of students may take some or all core subjects together;

- Establishing a place where groups of students can meet and study with one another, especially at commuter campuses; and
- Offering scholarships, grants, and funding for research projects.

- ***Undergraduate Research:***
  Enable students to become directly involved in ongoing research by:
  - Encouraging faculty to include funding for undergraduate researchers in their research proposals;
  - Offering student internships;
  - Having students write and present research findings (both on campus and at conferences);
  - Establishing liaisons with businesses and other universities to expand the opportunities for graduate research; and
  - Maintaining a supportive environment in which a student may experiment (and fail) without negative consequences.

- ***Faculty Development:***
  Support recruitment, retention, and professional development of faculty by:
  - Funding research, conferences, and professional development;
  - Offering mentoring opportunities;
  - Setting appropriately balanced (and rewarded) teaching and research agendas; and
  - Providing professional development on interactive classroom methods and mentoring as well as integrating student researchers into faculty research activities.

- ***Curriculum Development:***
  Align curricula with accepted content standards and develop courses that are relevant to the marketplace, community, and student population by:
  - Providing developmental courses that elevates entering students up to a required standard;
  - Integrating curriculum to help students build connections;
  - Introducing relevant history and culture into all courses;
  - Ensuring culturally responsive pedagogy; and
  - Developing new courses and majors.

- ***Physical Infrastructure:***
  Upgrade and maintain facilities and equipment by:
  - Renovating classrooms and laboratories;
  - Purchasing, upgrading, and maintaining state-of-the-art equipment; and
  - Designing spaces for students to meet and study.

- ***Graduate and Science Career Initiatives:***
  Facilitate admission and retention in STEM graduate programs and careers by:
  - Providing graduate school admissions test preparation courses;
  - Educating students on academic and professional supply and demand trends in STEM fields;
  - Establishing a bridge program for students transitioning out of college; and
  - Providing job placement services.

Evidence of Impact

Over the program's 11 years, the Principal Investigators at each of the MIE sites have implemented and improved the MIE model, experiencing success at various levels. IHEP, along with its program partners—Systemic Research, Inc. and the American Institutes of Research—measured evidence of MIE's impact by conducting site visits and collecting and analyzing enrollment, degree attainment, and faculty data.

Though not all of the causes for broad institutional change can be isolated, compared to nationwide enrollment and graduation, the numbers at MIE institutions were noticeably higher. Between academic years 1994–95 and 2002–03, enrollment in STEM majors increased by 16 percent nationwide, while at MIE institutions, enrollment in STEM majors increased by 24 percent (Systemic Research 2004). Likewise, the difference between the total STEM degrees awarded nationwide and those awarded by MIE institutions was substantial. Between 1993–94 and 2001–02, the total number of STEM degrees conferred nationwide rose 19 percent while they rose by 46 percent at MIE institutions (Hill 2000).

Replication of the MIE Strategies

The lessons learned from the MIE program are valuable in both synthesizing a broader model for other institutions of higher education to replicate, as well as, revealing larger policy recommendations to further support STEM education. The next phase of the MIE program will be to harness the successful elements of the model implemented on the six MIE campuses into a replicable model. Data collection and input from the principal investigators suggest, in addition to the strategies outlined above, the following elements are critical to success of the MIE model:

- Committed administrators, faculty, staff, and students to collaborate with principal investigators;
- Multifaceted and long-term implementation;
- Substantial resources invested in data-gathering and analysis; and
- Pedagogies with a high degree of collaboration between and among students and faculty in the classroom and while conducting research.

Policy Recommendations

At the state and federal level, aid to build infrastructure, increased research activities, and expanded financial aid for students would significantly contribute to the necessary preparation of the next generation of STEM graduates.

State-level contributions could include:

- Funding multi-year capacity-building efforts;
- Supporting research within the mission of MSIs; and
- Reviewing K–16 policy options.

Federal policies could include:

- Increasing funding for community research grants;
- Expanding funding for minority-serving graduate institutions;
- Providing more funding for research at the community college level;
- Supporting the American Competitiveness Initiative; and
- Continuing to bolster funding for Title III and Title V of the Higher Education Act.


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Introduction

The Model Institutions for Excellence (MIE) program has been an 11-year partnering effort for the National Science Foundation (NSF), the National Aeronautics and Space Administration (NASA), and six minority-serving institutions (MSIs). The program aims to increase ethnic and racial diversity in the science, technology, engineering, and mathematics (STEM) disciplines. This report on the MIE program has three major purposes:

1. To provide the national perspectives and history that led to the program's inception;
2. To record how the collective investments by NSF and NASA have contributed to success in STEM education; and
3. To identify the phases and areas of success in the MIE program so that other institutions can replicate them.[1]

Sources for this report include the work of two MIE program partners: the American Institutes for Research (AIR) and Systemic Research, Inc. In 2005 AIR published a separate study to document MIE's impact. In that study, AIR compiled a variety of statistics such as the enrollment of and degrees earned by students of color in STEM fields. AIR also reviewed national datasets to provide a backdrop for the MIE statistics, and mined periodic status reports and other material the MIE institutions produced. To tell the human side of the statistics, AIR visited all the MIE sites and met with program participants representing various levels at each institution—presidents, faculty, students, graduates, staff, and principal investigators (PIs).

Since the program's inception, Systemic Research, Inc., has collected a broad range of quantitative data from the MIE institutions. It has compiled the data in yearly fact books that provide progress reports and offer key indicators against which various years of MIE implementation can be measured (Systemic Research, Inc. 2005). Explicit descriptions of each institution's model also are included in the fact books.

To expand on the work of these two partners, staff at the Institute for Higher Education Policy (IHEP) contributed new data by participating in site visits and making additional observations. IHEP staff

Institute for Higher Education Policy, 2005

The MIE PIs in 2005. *Left to right:* **Dr. Benjamin Flores, University of Texas at El Paso; Dr. Elaine Davis, Bowie State University; Stacy Phelps, Oyate Consortium; Dr. Tuajuanda Jordan, Xavier University of Louisiana; Dr. Albert Thompson, Spelman College; and Dr. Juan Arratia, Universidad Metropolitana.**

[1]This report is part of a series of activities supported by the National Science Foundation under Award No. HRD-0443372 to the IHEP to disseminate information regarding the MIE program. The MIE dissemination grant is co-managed by the Hispanic Association of Colleges and Universities, National Association for Equal Opportunity in Higher Education, and American Indian Higher Education Consortium under the umbrella of the Alliance for Equity in Higher Education (www.msi-alliance.org). The authors wish to thank the Alliance partners as well as NSF Program Officer David Temple for their support and encouragement for this project.

conducted interviews with the PIs and collected other specific program information. Moreover, IHEP staff reviewed qualitative and quantitative data sources, including annual reports from the MIE institutions, original analyses using U.S. Department of Education data on enrollment and completions, and other IHEP reports published about America's MSIs.

Putting MIE in Context

The relevance and effectiveness of the MIE program are rooted in the policy and institutional contexts of its time. The policy context framed MIE's central goal: to increase the number of students of color who enter STEM disciplines and become professionals in those areas. The institutional context framed the program's implementation to take full advantage of traditions at institutions that have demonstrated success in educating students of color—Tribal Colleges and Universities (TCUs), Hispanic-Serving Institutions (HSIs), and Historically Black Colleges and Universities (HBCUs).

Table 1: Employment by occupation, 2002, and projected 2012 (numbers in thousands of jobs)

2000 standard occupation classification code	Employment		Change		Total job openings due to growth and net replacements, 2002–2012[1]
	2002	2012	Number	Percent	
SCIENCES					
Life scientists	214	253	39	18.2%	91
Physical scientists	251	287	36	14.4%	100
Life, physical, and social science technicians	346	397	51	14.8%	130
Natural science managers	45	51	5	11.3%	14
Agricultural managers	1,376	1,149	-227	-16.5%	117
Farming, fishing, and forestry occupations	1,072	1,107	35	3.3%	335
Dietetic technicians	29	35	6	20.2%	10
TECHNOLOGY					
Computer and information systems managers	284	387	103	36.1%	154
Computer and mathematical science occupations	3,018	4,069	1,051	34.8%	1,465
ENGINEERING					
Engineers	1,478	1,587	109	7.3%	431
Engineering managers	212	231	20	9.2%	62
Engineering technicians, except drafters	478	526	48	10.1%	148
MATHEMATICS					
Mathematical science occupations	107	115	8	7.4%	36
Financial specialists	2,268	2,696	429	18.9%	832
Cost estimators	188	223	35	18.6%	77
Financial managers	599	709	109	18.3%	195

[1]Total job openings represent the sum of employment increases and net replacements. If employment change is negative, job openings due to growth are zero and total job openings equal net replacements.

Note: Detail may not equal total or 100 percent due to rounding.

Source: Adapted from "Table 2. Employment by occupation, 2002 and projected 2012" in the *Monthly Labor Review*, September 2005, available online at http://www.bls.gov/emp/empocc1.htm and accessed on November 3, 2005.

Policy Context: Quantity, Quality, and Diversity

When President George W. Bush declared in his 2006 State of the Union Address that "we need to encourage children to take more math and science," he joined an ongoing debate over whether the future of the STEM workforce in the United States is in jeopardy. While numerous reports and articles contend that a crisis is looming, opinions diverge.

The degree of divergence depends on how the quantity, quality, and diversity of the future STEM workforce are portrayed. One set of debates on quantity focuses on whether the nation is producing enough graduates in the STEM fields to meet future workforce needs. For instance, a 2005 publication from the American Association for State Colleges and Universities pointed to an average annual increase of only 3 percent in students applying to graduate programs in selected STEM fields between 1986 and 2004, and an average annual increase of only 1–2 percent in students enrolling in graduate programs in these fields during the same period. By comparison, the same study predicted a 47 percent increase in science and engineering jobs by 2010 (Russell and Siley 2005). Such increases may be particularly steep in the technology field (See table 1 for comparative data).

The strong connections with history and the civil rights struggle permeate the culture and curricula at Historically Black Colleges and Universities.

Similar comparisons have been made since 1985 when NSF warned the nation about potential workforce shortages. However, detractors challenged those early predictions (Monastersky 2004). They compared the prior urgency with subsequent job market reports and conclude that surpluses—not shortages—exist in STEM careers. Others suggest that from 2006 on, only "thousands, not millions" of American students are needed to sustain the current STEM workforce (Samuelson 2006).[2]

While the issue of workforce quantity has its detractors, a contention gaining consensus is one of quality, namely that America is losing its competitive edge. For example, in a report titled "Tapping America's Potential: The Education for Innovation Initiative," a broad coalition of business and education leaders described STEM superiority as "one of the pillars of American economic prosperity" (U.S. Chamber of Commerce 2005). President Bush also used the context of American competitiveness to promote a set of policy objectives during his 2006 State of the Union Address: increased funding for training high school teachers in math and science; 30,000 new math and science professionals who can teach with alternative certification; and early intervention for students who struggle with STEM subject matter.

Congress has echoed President Bush's initiative by considering three bills that capture some presidential elements and advance a few congressional ideas. Notably, the Science and Mathematics Education for Competitiveness Act of 2006 would provide scholarships and professional development for math and science teachers, partnership opportunities between higher education institutions and other educational entities, and grants to improve undergraduate education in the STEM fields.

[2]In 2005, the U.S. Bureau of Labor Statistics projections of STEM employment needs show many of the STEM fields to hover around the general occupational average of 15 percent. The exception is the technology area, which anticipates a 36 and 34 percent change in demand for computer and information systems managers or computer and mathematical science occupations.

MSI Definitions

Historically Black Colleges and Universities (HBCUs) and Predominately Black Colleges and Universities: are federally designated colleges that began operating in the 19th century to serve African Americans who were prohibited from attending predominantly White institutions (O'Brien and Zudak 1998).

Hispanic-Serving Institutions (HSIs): Federal statute defines HSIs as institutions that have at least a 25 percent Hispanic undergraduate full-time-equivalent enrollment, with at least 50 percent of its Hispanic students coming from low-income backgrounds and being the first generation in their family to attend college (Benitez 1998).

Tribal Colleges and Universities (TCUs): The majority of TCUs are colleges that were chartered by one or more American Indian tribes and are based on reservations or in communities with large American Indian populations. Most of these colleges are two-year institutions that are less than 35 years old and have relatively small student bodies. (Boyer 1997; Cunningham and Parker 1998).

Alliance for Equity in Higher Education: Founded in 1999, the Alliance for Equity in Higher Education is comprised of three organizations dedicated to educating minority students — the American Indian Higher Education Consortium (Dr. Gerald Gipp, executive director), the National Association for Equal Opportunity in Higher Education (Dr. Lezli Baskerville, president and CEO), and the Hispanic Association of Colleges and Universities (Dr. Antonio Flores, president and CEO). Together, the Alliance member organizations represent more than 350 MSIs, which educate more than one-third of all students of color in the United States. Serving as fiduciary agent for the Alliance is the Institute for Higher Education Policy (Jamie P. Merisotis, president).

Along with a focus on the quantity and quality of the future STEM workforce, concerns also exist about the diversity of that workforce. Even those who have disputed the claims of potential STEM professional shortages acknowledge the paucity of students of color studying math and science.

NSF's Committee on Equal Opportunity in Science and Engineering captured the concerns over quantity, quality, and diversity in a report titled "Broadening Participation in America's Science and Engineering Workforce" (2005). In the preface, the authors called for a workforce that includes workers with diverse ways of working and thinking, and contended that continuing American leadership in the STEM fields will be based on "the healthy development of the science and engineering talent of *all* its citizens."

The report then looked at how NSF-funded programs addressed the quantity, quality, and diversity needs of the nation, and found that funding to broaden participation in STEM fields had been sustained since 1980, but other efforts that had a minority student focus (such as a minority graduate fellowship program) had been legally challenged and subsequently eliminated.

The report also found that, despite the best efforts of NSF and other federal agencies, underrepresentation of minorities in STEM fields persists. Thus, committee members recommended that "NSF should continue to support effective programs targeted to minorities. NSF should also consider replicating these programs nationally for greater impact."

Institutional Context: Minority-Serving Institutions

While MSIs have different historical origins, they share three characteristics relevant to MIE. One, by either mission or mandate, MSIs provide an institutional climate that reflects the cultures of the students of color they enroll. Two, despite their clear missions, traditionally MSIs are severely underfunded. Three, although MSIs can offer STEM disciplines, many lack the capacity to attract, retain, and support competitive STEM students. Each group of MSIs approaches education in uniquely different ways.

The first characteristic, evidence of an institutional climate at MSIs that reflects the cultures of students of color, can be found in the architecture, customs, and teaching methods present at TCUs. At institutions such as Diné College, which the Navajo Nation founded, the central administration building is built in the same octagonal shape as the traditional Navajo homes—called hogans—found throughout the rest of the reservation. At the center of that administration building is an enclosed room reserved for traditional ceremonies. Diné's spirit of cultural preservation is also maintained through its Navajo language courses.

The strong connections with history and the civil rights struggle permeate the culture and curricula at HBCUs. At schools such as Bethune-Cookman College, which was named after the famous educator, Mary McLeod Bethune, and Tuskegee University, which Booker T. Washington[3] co-founded, the mission to educate black students is clear and unmistakable.

Many Hispanic-Serving Institutions use Spanish within their curricula and in general communication throughout their campuses to overcome limited English proficiency. The spirit of such bilingual education can be traced back to the first Hispanic-Serving Institution, the University of Puerto Rico, which was founded in 1903. The university was founded the year after Puerto Rico was declared a U.S. territory, and a year after English was introduced as the co-official language. So for many HSIs, the issue of bilingualism represents an institution's attempt to reconcile its academic mission with its students and its history.

The second common characteristic among MSIs is their constant challenge to obtain adequate funding. Title III and Title V of the Higher Education Act are the principal sources of funding for MSIs, but funds are split among more than 270 institutions (U.S. Department of Education, Institutional Development and Undergraduate Education Service 2006). In areas such as physical infrastructure, technology, and resource-intensive disciplines of STEM, MSIs are doing much more with much less.

Funding from U.S. federal agencies such as the Department of Health and Human Services, the Department of Defense, and NASA helps MSIs build capacity (Bennof 2004), but the levels of funding have not kept pace with enrollment between 1999 and 2004.[4] Funding

The second common characteristic among MSIs is their constant challenge to obtain adequate funding.

is also insufficient for many MSIs to meet the challenges created by infrastructure upgrade requirements, academic research needs, technological advancements, and competition from non-MSIs (President George W. Bush's Board of Advisors on Historically Black Colleges and Universities 2005; Institute for Higher Education Policy 2004).

The third characteristic of MSIs is the greater role they play in serving nontraditional and low-income students. Partly because of the substantive number of two-year institutions among MSIs, all TCUs, 36 percent of HBCUs, and 65 percent of HSIs have an open admission policy (U.S. Government Accountability Office 2004). This policy provides access

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[3]Washington's autobiography, *Up from Slavery*, chronicles his journey from servitude to education and then to the establishment of the Tuskegee Institute, as it was called then. That journey symbolized a popular belief of the time that education and liberation were synonymous.

[4]Based on IHEP's rough estimates of Integrated Postsecondary Data Analysis System data, 2006.

to a broader range of students than traditional institutions but also increases the range of potential services that MSIs must provide.

For MSIs, raising tuition to meet funding gaps is not practical. In 2004, the U.S. Government Accountability Office reported that 78 percent of TCU students, 59 percent of HBCU students, and 57 percent of HSI students received federal aid such as Pell grants. Those numbers compare with only 27 percent of students nationally who received the same grants (U.S. Department of Education, National Center for Education Statistics 2005).

Despite the funding and resource gaps, however, the generations of achievers who have emerged from MSIs suggest that great potential remains. In 2004 the Government Accountability Office reported that nearly all MSIs use the federal aid they receive to improve academic quality. In addition, a number of students who have participated in MIE graduate from MSIs with the intent of investing their knowledge back into their communities, as the profiles provided later in this report will illustrate. That reinvestment

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comes in the form of researching public health issues endemic in their communities of origin, or in joining the STEM workforce to help the nation sustain its competitiveness. Tables 2 and 3 show MSIs producing about 11 percent of all associate's degrees and about 8 percent of bachelor's degrees in STEM fields (U.S. Department of Education, National Center for Education Statistics 2004a). However, with increased investment, greater production is possible. MSIs educate 29 percent of all students of color in undergraduate higher education. Tapping that potential takes leadership, creativity, and commitment.

Table 2. Associate's degrees completed in STEM fields at MSIs as a percentage of associate's degrees completed at all institutions, by gender and race/ethnicity, 2003–04

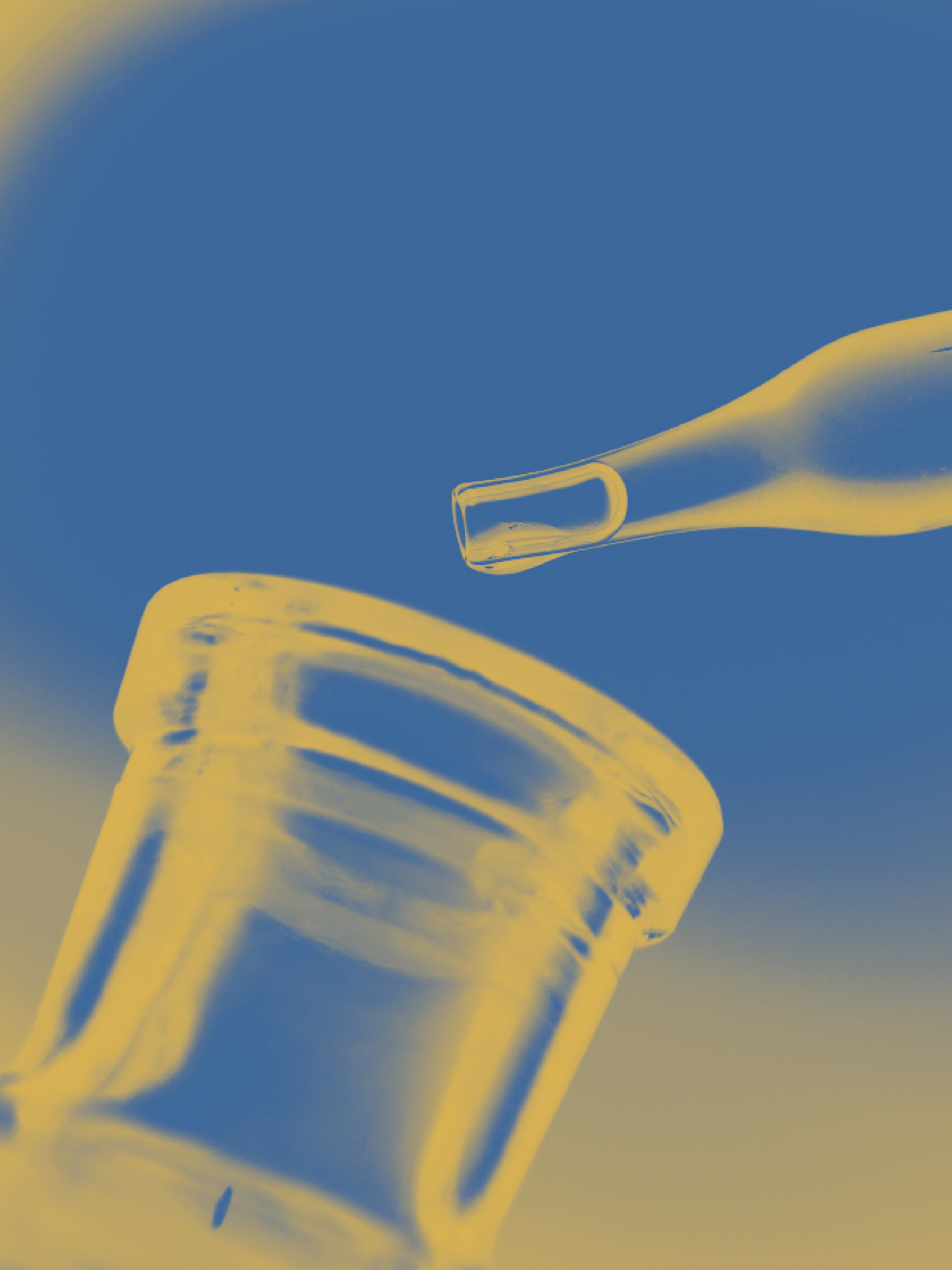
	Men	Women	Non-resident alien	Black non-Hispanic	American Indian/Alaska Native	Asian or Pacific Islander	Hispanic	White non-Hispanic	Race/ ethnicity unknown	Grand total
Science	14.2	19.9	17.7	20.1	34.1	25.3	56.6	8.8	22.6	18.3
Technology	6.3	8.7	21.3	8.8	21.1	10.9	21.2	3.5	2.7	7.0
Engineering	7.2	8.1	10.2	5.9	24.4	10.7	14.2	4.1	8.2	7.4
Mathematics	24.2	20.1	27.7	33.3	9.1	23.0	49.6	14.0	17.9	22.7
Total STEM	**7.9**	**14.7**	**19.7**	**12.3**	**26.8**	**15.6**	**33.9**	**5.4**	**7.0**	**10.9**

Source: U.S. Department of Education, National Center for Education Statistics 2004a.

Table 3. Bachelor's degrees completed in STEM fields at MSIs as a percentage of bachelor's degrees completed at all institutions, by gender and race/ethnicity, 2003–04

	Men	Women	Non-resident alien	Black non-Hispanic	American Indian/Alaska Native	Asian or Pacific Islander	Hispanic	White non-Hispanic	Race/ethnicity unknown	Grand total
Science	6.7	8.9	9.9	37.0	10.7	5.8	40.5	2.6	6.8	8.0
Technology	7.5	11.8	8.9	29.4	2.7	8.7	28.6	2.8	4.7	8.6
Engineering	6.8	8.5	9.1	25.3	8.6	5.6	42.9	2.0	6.3	7.1
Mathematics	5.8	8.2	5.9	42.6	12.1	4.2	33.2	2.7	7.0	6.8
Total STEM	**6.9**	**9.2**	**9.0**	**32.5**	**8.1**	**6.5**	**38.0**	**2.5**	**5.9**	**7.9**

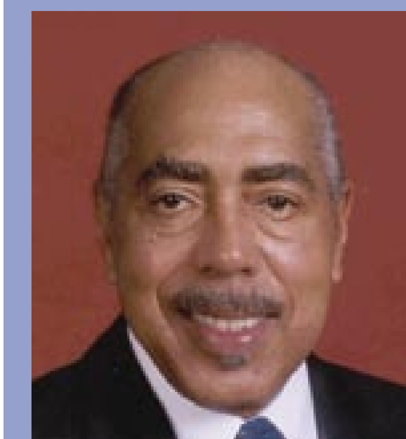
Source: U.S. Department of Education, Integrated Postsecondary Data Analysis System.



Part I: The History of the Program

MIE's Vision

The origin of the MIE program can be traced back to 1992 through a review of unpublished notes from the original organizational meetings. The notes show that Dr. Walter Massey, the NSF director at that time, envisioned the benefits that supportive institutional environments could provide for undergraduates in science, technology, engineering, and mathematics.[5] He believed that when an institution has the support to provide the most effective pedagogy and practice, student learning is greatly enhanced. After Dr. Massey made the case for a new initiative, NSF then convened a cross-directorate task force to continue developing programming principles. The resulting proposal was then approved by the National Science Board in 1994. Perhaps data also motivated Dr. Massey. While the statistics that described the participation of students of color in STEM disciplines leading up to 1994 would have provided reasons for hope, they also provided reasons for great concern.



Morehouse College, 2006

Dr. Walter Massey, originator of the MIE concept. His ideas for MIE were based on his experiences as the president of Morehouse College, where he observed the impact that the integration of research and education could have on the success of STEM students.

Between 1975 and 1993, for example, black and Native American students showed the largest gains in math SAT scores, improving 9 percent and 6 percent, respectively. However, as of 1993, both of those groups still showed a gap of forty points or more when compared with their white and Asian counterparts (College Board 2003). Twelfth-grade students of color were as interested as their white and Asian counterparts in taking math and science courses; yet course-taking patterns showed that students of color accumulated substantially

While students of color showed interest in studying math and science, that interest did not lead to advanced academic pursuits in those disciplines. … Dr. Massey convened a task force to identify MSIs that have shown promise in preparing students in STEM fields … Those institutions became the Model Institutions of Excellence.

fewer credits in advanced courses such as algebra or in science courses in general (U.S. Department of Education, National Center for Education Statistics 2004b). So while students of color showed interest in studying math and science, that interest did not lead to advanced academic pursuits in those disciplines. To change this pattern, Dr. Massey convened a task force to identify MSIs that have shown promise in preparing students in STEM fields, provide those institutions with the funds to implement an additional set of strategies intended to enhance their potential, and analyze the results. Those institutions became the "Model Institutions of Excellence."

[5]The following sections that describe the MIE development process are based on notes from and interviews with NSF program staff.

Program Design Imperatives

During the conceptualization of the MIE program, the task force established several key design imperatives. The first was to ensure that **the program would have a beginning and an end**. After at least five years of funding, MIEs would be guided through a two- to three-year set of transition phases that would move the participating institutions from direct NSF funding to other funding sources and that would assist in the institutionalization of MIE-tested practices (see the appendix under MIE Institutionalization Efforts).

The second design imperative was to **develop the MIE concept jointly** between NSF's education and human resources **directorate** and the research and related directorates. The intent of this deliberate collaboration was to attach explicit research outcomes with the objectives related to education and research needs in STEM.

The third design feature was expressed in the evaluation process. Once the program began, it was intended that **MIE would become an example of effective formative evaluation or continuous programmatic improvement**. Improvement strategies were to be based on evaluations provided by technical consultants. Those consultants would then advise the MIE institutions on ways to improve program development and implement the grant's fundamental goals.

The MIE Program's Goals

After constructing the design features, the task force turned to the program goals and more specific objectives. The overall goal was to have an impact both on MSIs and the students of color that they serve. Eleven years later, as each institution guides its portion of the MIE program to sustainability, the schools continue to pursue these original goals:

- To improve the quality of STEM education and undergraduate research;
- To promote overall institutional progress while emphasizing the development of STEM departments and programs;
- To create STEM education reform models that are student centered, accountable, and performance driven;
- To increase the number of STEM baccalaureate degrees conferred and the percentage of STEM graduates enrolling in graduate school; and
- To disseminate best-practice STEM models that can be replicated in institutions throughout America.

The Selection Process

The institutions that emerged from the MIE selection process faced substantial competition. Fifty-seven MSIs initially submitted proposals. Of that number, twenty received planning grants. The final six institutions were selected by a blue ribbon panel that conducted site visits to finalize their choices. The initial awards were made in 1995. The NSF-funded schools—Universidad Metropolitana, Xavier University of Louisiana, the University of Texas at El Paso (UTEP), and the Oyate Consortium—each received about $22 million during the 11 years of funding. The NASA-funded schools—Spelman College and Bowie State University—received $18 million and $14 million, respectively (American Institutes for Research 2005).

Part II: The Aggregate MIE Model

While the broad goal of the MIE program was to increase the numbers of students of color pursuing STEM professions, each participating institution implemented its own set of objectives to achieve that larger goal. Viewing the MIE institutions as a whole, the combined or aggregate MIE model suggests strategies that affect the entire institution. The American Institutes for Research composed this description of the model in 2005 based on site visits and interviews with the PIs.

The MIE Model: Strategic Areas of Impact

- **Recruitment and transition initiatives:** Prepare matriculating students to succeed in college and to introduce students to STEM disciplines and careers by:
  - Training elementary, middle, and high school teachers to improve their content knowledge and teaching ability;
  - Introducing young students to the STEM fields through hands-on activities (e.g., science fairs or geographic information systems mapping); and
  - Bridging the transition from high school or community college into college or university (e.g., summer orientation programs).
- **Student support:** Provide social, financial, and academic assistance to students by:
  - Supporting peer and teacher/student mentoring programs;
  - Tutoring;
  - Providing and advising on opportunities for financial aid;
  - Starting each course at the point at which most students have sufficient background to understand basic concepts;
  - Scheduling "cohort" programs in which a small group of students may take some or all core subjects together;
  - Establishing a place where groups of students can meet and study with one another, especially at commuter campuses; and
  - Offering scholarships, grants, and funding for research projects.
- **Undergraduate research:** Enable students to become directly involved in ongoing research by:
  - Encouraging faculty members to include funding for undergraduate researchers in their research proposals;
  - Offering student internships;
  - Having students write and present research findings (both on campus and at conferences);
  - Establishing liaisons with businesses and other universities to expand the opportunities for graduate research; and
  - Maintaining a supportive environment in which a student may experiment (and fail) without negative consequences.
- **Faculty development:** Support recruitment, retention and professional development of faculty by:
  - Funding research, conferences, and professional development;
  - Offering mentorship opportunities;

- Setting appropriately balanced (and rewarded) teaching and research agendas; and
- Providing professional development on interactive classroom methods and mentoring, as well as integrating student researchers into faculty research activities.

▶ **Curriculum development:** Align curricula with accepted content standards and develop courses that are relevant to the marketplace, community, and student population by:
- Providing developmental courses that elevates entering students up to a required standard;
- Integrating the curriculum to help students build connections;
- Introducing relevant history and culture into all courses;
- Ensuring culturally responsive pedagogy; and
- Developing new courses and majors.

▶ **Physical infrastructure:** Upgrade and maintain facilities and equipment by:
- Renovating classrooms and laboratories;
- Purchasing, upgrading, and maintaining state-of-the-art equipment; and
- Designing spaces for students to meet and study.

▶ **Graduate and science career initiatives:** Facilitate admission and retention in STEM graduate programs and careers by:
- Providing graduate school admissions test preparation courses;
- Educating students on academic and professional supply and demand trends in STEM fields;
- Establishing a bridge program for students transitioning out of college; and
- Providing job placement services.

Empirical Evidence of Impact

Evidence of MIE institution impact in the areas mentioned above is captured both by the 2005 impact study published by AIR and by the series of fact books published by Systemic Research, Inc. Both sets of studies provide a rich source of evidence to demonstrate the changes that have taken place at the MIE institution during the period of NSF and NASA funding. Overall, that evidence shows substantial gains in enrollment, in degrees granted, and in STEM faculty hired. Interviews with faculty and other staff also point to institutional changes that enhanced academic and programmatic capacity.

AIR studied five of the six MSIs and compared STEM enrollment data with total enrollment at each site. Universidad Metropolitana had the highest increase at 106 percent. That was followed by Bowie State University at 71 percent. The other three institutions, UTEP, Xavier University of Louisiana, and Spelman College experienced increased STEM enrollment at 24 percent, 19 percent, and 8 percent, respectively (American Institutes for Research 2005).

The enrollment trends revealed that each institution also showed an increase in STEM enrollment in most of the MIE intervening years when using 1997 as the starting point and ending in 2004. That growth was paralleled by growth in total enrollment at the institutions, but in each case, except for Universidad Metropolitana, the percentage growth in STEM students was higher than the percentage growth in total enrollment.

Though data were not available for some institutions, gains in degrees awarded seem pronounced. For example, Bowie State University's 307 percent increase in the number of STEM degrees awarded is more than four times its STEM enrollment increase between 1997 and 2004. And while Universidad Metropolitana's STEM enrollment doubled, STEM degrees awarded increased 185 percent (American Institutes for Research 2005).

Other evidence of impact or "outcomes" includes the following (Institute for Higher Education Policy 2005, American Institutes for Research 2005):

- At every institution except Spelman College (where they made a strategic decision to admit fewer students who planned to enter STEM programs), the increase in STEM degrees awarded was higher than the increase in the total number of degrees awarded.
- The number of STEM faculty members increased at every MIE except Spelman, and increases ranged from 15 percent to 148 percent.
- Previously having had no STEM degree programs, Oyate Consortium created eight during MIE funding.
- Universidad Metropolitana added eight STEM initiatives aimed at undergraduate and K–12 students.
- The MIE program convinced administrators and faculty that students of color harbor great potential for success in the STEM fields.

AIR also convened a panel of experts and professionals who have significant experience in education for the evaluation. Those experts were asked to provide a list of factors related to higher education success in STEM. They were then asked to determine the extent to which MIE elements matched those factors. Following are the categories of MIE elements and some of the associations the experts identified with success (for a complete list, please refer to the full impact study—American Institutes for Research 2005).

- Recruitment and transition initiatives
  - Build K–16 partnerships.
  - Engage K–12 students early and continuously in STEM-related workshops, Saturday activities, etc.
- Student support
  - Ensure seamless, comprehensive, holistic, and visible support services.
  - Ensure adequate financial support in the form of scholarships, grants, stipends, and incentives.
- Undergraduate research
  - Encourage culturally and contextually relevant research.
  - Link academics and research to graduate school and the workforce by making students aware of opportunities.
- Faculty development
  - Recruit faculty members of color.
  - Develop initiatives to commit faculty to interactive teaching and learning methods and to engage students in collaborative research projects.
- Curriculum development
  - Develop a pedagogy and curriculum that are culturally responsive and student centered.
  - Align comprehensive STEM curricular offerings with the institution's STEM goals.

Glossary of Terms for MIE Model

Terms used to describe the activities and results involved in MIE might seem synonymous. But here is a glossary of those terms:

Model describes the phases of impact such as investment, distribution, and integration.

Impact describes broad sets of results of the NSF and NASA investments.

Strategy describes an approach being implemented or objective being met by an activity.

Component describes a set of activities such as student development, faculty development, or physical infrastructure development.

Element describes one particular activity within a larger component.

Outcome or Result describes approximate effects of the strategy, element, or activity, such as the creation of a STEM-focused tutoring program based on data showing high withdrawal rates for gateway courses, or scientific accomplishments resulting from the investment in particular laboratory equipment.

- Physical infrastructure
  - Provide adequate, up-to-date physical space (e.g., classrooms, laboratories, and student study centers) and equipment that supports both instructional goals and research opportunities for faculty and students.
  - Develop alliances with businesses and community partners to design strategic funding plans and capital campaigns.
- Graduate and science career initiatives
  - Plant seeds for graduate school by providing STEM career information early in K–12 and early in the undergraduate experience.
  - Ensure K–16 curricular alignment—providing a more seamless pathway of course taking between high school and postsecondary education.

Comparing the indicators the panel suggested as success factors for STEM programs to the corresponding elements of the MIE program suggests that the program has been relevant and effective.

Phases of Impact

Another way to describe MIE's impact is to consider how the continuous investment and implementation fostered long-term change. The initial investment made it possible for the PIs or program associates to turn strategies into actual program elements. Feedback from evaluators or collaborators generated additional strategies. PIs could implement new activities or program elements. And, as one revolution of this cycle of impact was completed, the scope of MIE also grew. In the more developed version of the MIE impact cycle were five phases:

1. Investment
2. Distribution
3. Integration
4. Production
5. Reinvestment

As part of the dissemination effort, IHEP refined this schema to describe how MIE functions at its campuses. These five phases are essential elements of successful MIE activities and serve as a checklist for replicating the program at other campuses.

Each of these phases is depicted in figure 1. The boxes of text show examples of the results generated during each phase. The arrows show the path of impact from one phase to the next. Following the conceptual model are short descriptions of each phase, accompanied by examples.[6]

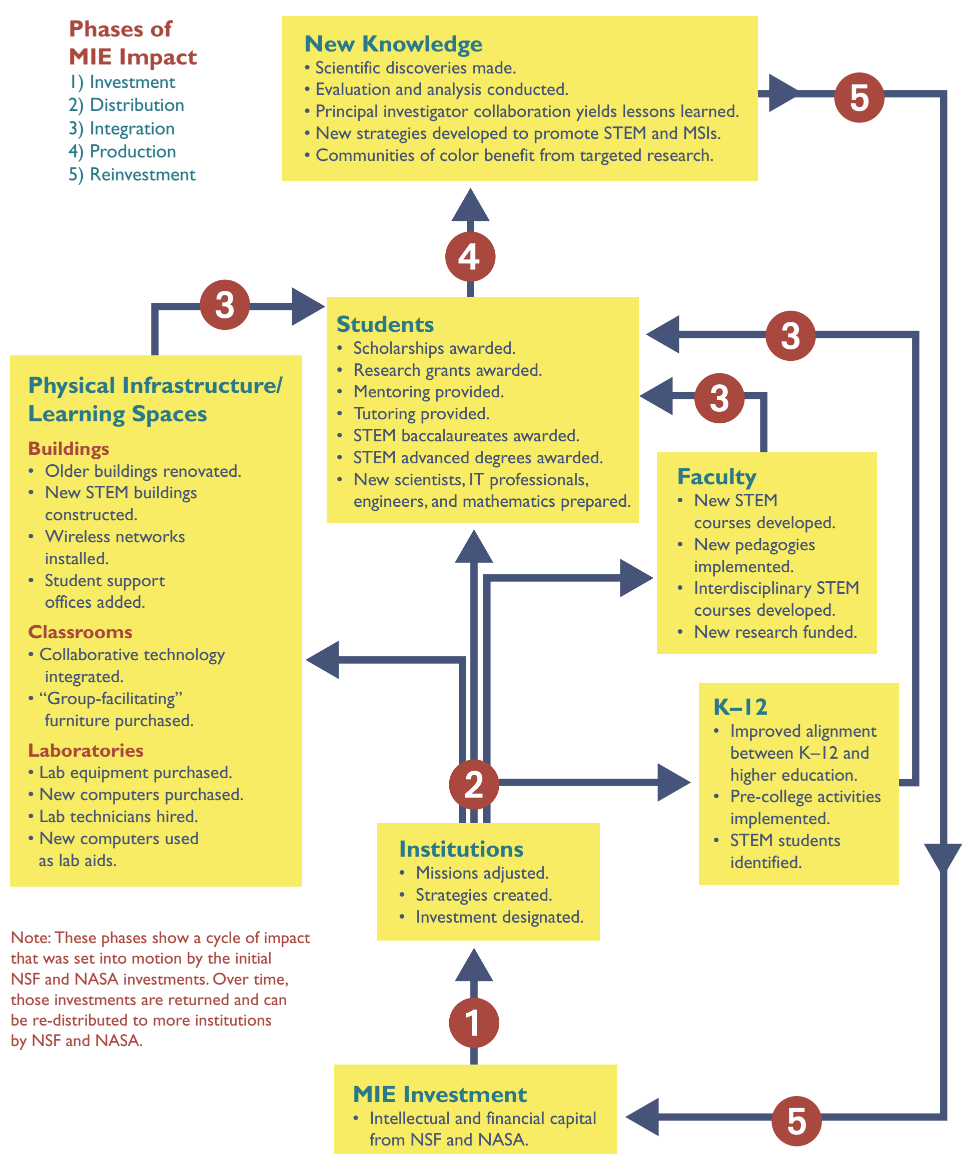
[6]During the description of the phases of impact and in subsequent sections, examples of institutional activities or strategies are drawn from interviews or observations during site visits conducted by IHEP and AIR staff during fall 2004.

Phase 1: Investment

The investment phase began when the MSIs received intellectual and financial capital from NSF and NASA. It is important to note that NSF and NASA provided more than money to each institution; each institution received feedback from reviewers on their initial grants, technical assistance at the launch of its grants, and ongoing assistance from NSF and NASA, a significant combination of financial and intellectual investments.

Also, occurring in this phase is the reaffirmation of each institution's mission. As each institution received significant investment from its grantors, each institution also had to

Figure 1: The Cycle of Impact in Five Phases



Note: These phases show a cycle of impact that was set into motion by the initial NSF and NASA investments. Over time, those investments are returned and can be re-distributed to more institutions by NSF and NASA.

review its priorities. For instance, while UTEP has a long history of producing engineers, only recently has the institution emphasized the production of *Hispanic* engineers. Spelman College has a long history of producing black women scientists, but the significant MIE investment meant balancing STEM priorities against Spelman's strong liberal arts tradition. At Oglala Lakota College, because its STEM-related facilities previously had been very limited, the new investment meant launching a new, broader mission to support MIE goals.

Some institutions made their affirmations, or reaffirmations, by explicitly stating them on institutional Web sites. Others worked more quietly by changing lines in budgets and reallocating resources. But in either context, the impact of the investment phase can be observed by looking at how the institution operated "post-investment."

In two cases, faculty and deans raised concerns that the "balance of influence" between the liberal arts and STEM sides of their institutions had been upset by the new STEM investment. Faculty suggested that the increased focus on STEM disciplines necessarily meant a diminished focus on liberal arts. To address their concerns, MIE PIs broadened some of the activities intended for STEM students to include liberal arts students to achieve broad-based participation in the benefits of the new investment (see the description of the Academic Centers for Engineers and Scientists at UTEP described below).

Phase 2: Distribution

Once institutions received the STEM investment from NSF and NASA, they channeled the new resources toward strategies that support broader institutional goals. Resources were distributed across four primary areas: (1) physical infrastructure and capacity building, (2) faculty development, (3) student development, and (4) precollege activities. Following are descriptions of those strategies.

Physical Infrastructure and Capacity Building

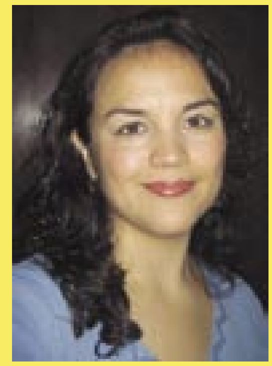
Improvements to physical infrastructure could be achieved by several approaches. One approach was to create learning spaces that would facilitate new approaches to learning. To fulfill that purpose, two institutions purchased classroom and laboratory furniture that they could easily rearrange into group seating. Changing the student orientation is a noted key to facilitating collaborative learning.

Spelman College, 2004

Left to right: Spelman Chemistry Lab—Before: Individual student lab stations. After: Collaborative work stations.

STUDENT PROFILE

Dr. Brisa Sanchez, UTEP



Dr. Brisa Sanchez, 2006

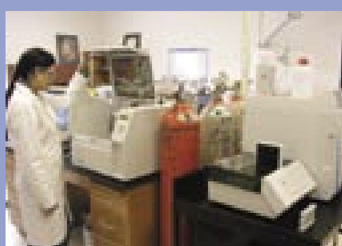
Dr. Brisa Sanchez attributes her success in her STEM program to the mentorship she found by participating in MIE summer and research programs at UTEP and the Mathematical & Theoretical Biology Institute at Cornell University. Mentorship was particularly important in helping her overcome feelings of isolation from other Mexicans and contradicting her family's expectations of traditional behavior.

Brisa has continued her interest in STEM fields since graduating from UTEP, having received her doctorate in biostatistics at the Harvard University School of Public Health. She reports, "In recent collaborations, we [she and her colleagues] studied the concentration of fast-food restaurants in area neighboring schools in the city of Chicago. From that research we concluded that fast-food restaurants are in closer proximity to schools than would be expected if they were randomly distributed across the city. This provides some evidence that the fast-food industry targets school-aged children as a major component of their client pool. The public health significance of this research is immediate given the obesity epidemic this country faces today."

Another approach was to provide more STEM-related student support. Each institution created support offices for MIE program staff. Several of the institutions also created tutoring centers. UTEP consolidated the two ideas by creating resource centers for students that combined new learning spaces with student support. The UTEP Academic Centers for Engineers and Scientists were built to provide group study areas, wireless access, tutoring, meeting rooms for student organizations, internship and job market information, and other research events. UTEP also opened these areas to students from liberal arts divisions.

The UTEP Academic Centers for Engineers and Scientists were built to provide group study areas, wireless access, tutoring, meeting rooms for student organizations, internship and job market information, and other research events.

Yet another infrastructure approach was to provide the technology tools that students need to enhance their learning opportunities. Along with the wireless access the Academic Centers for Engineers and Scientists provided, other institutions provided video conferencing and smart boards. Smart boards allow an individual to write text on a "whiteboard" in one classroom and have the text also appear in a remote location.



Oglala Lakota College, 2004

Top to bottom: Oglala Lakota College Science Trailer before MIE. EPA analytical testing lab afterwards.

Laboratory construction and renovation inspired an even more robust upgrade of technology tools. Each institution was able to create or improve lab facilities through the purchase of research equipment, lab stations, or computers to assist in analyzing data. Such improvements were substantial at all the institutions, but perhaps had the largest impact at Oglala Lakota College. Before the MIE funding, Oglala's STEM students had to conduct their science experiments in trailers.

By 2005, the Oglala campus had built a science building and added 11 new computer labs, three biochemistry labs, an analytical testing lab certified by the Environmental Protection Agency (EPA), and a remote sensing/geographic information systems lab.

The investment in physical infrastructure also allowed institutions to provide a home for MIE activities. Each institution either built or renovated its STEM buildings by leveraging MIE funds. Such funds made it possible to provide state-of-the-art laboratories and install new technology systems.

Faculty Development

Another key institutional goal was to provide creative license for faculty. In some cases, MIE provided the opportunity for faculty to create new STEM courses. Changes in

STUDENT PROFILE

Kimberly M. Jackson, Ph.D., MIE Scholar-Teacher, Spelman College

Kimberly M. Jackson, Ph.D., continues to recognize her MIE experience as one that will provide a lifetime of rewards and benefits. "I joined the Biology Department at Spelman College as a MIE scholar-teacher. This position fostered my development as both scholar-teacher and researcher by allowing an equal percentage of my time to be dedicated to teaching and researching. Being a biochemist and having interests that bridge the interface between chemistry and biology, the MIE program allowed me to experience teaching in both the Chemistry and Biology Departments."

"My research focuses on the use of various natural products (diet-derived agents), such as tea (green and black), curcumin, resveratrol, and quercetin, as potential cancer chemo-preventive agents for human lymphoma, leukemia, and prostate cancer cell lines. Epidemiological studies concerning natural product consumption and human cancer risk are being examined as well as trends in prostate cancer incidence among African Americans in different geographical localities. MIE has helped me to develop a strong independent research program by protecting my time to do research and providing the necessary funds to maintain my laboratory. Due to my research and teaching experiences under the MIE program, I now feel confident that I have a competitive research program and an array of varied teaching experiences such that I can obtain a tenure-track position at the college or university of my choice."

STUDENT PROFILE

Jim Sanovia, Oyate Consortium

Jim Sanovia attributes his continued motivation to complete his engineering degree to scholarships. Financial support from the scholarships allowed him to take part in research and internship opportunities without having to worry about income. Conducting research and bonding with other Native American students at his institution kept him motivated as well. These factors were especially important in helping Jim to realize the power of an educational degree to provide greater long-term benefits than immediately entering the workforce in a job such as construction.

Jim is now working with remote sensing and geographical information systems to preserve his Native American culture by educating his people as well as the public. He teaches about satellite technology and mapping software through and in light of his culture, rather than being isolated from that cultural framework.

institutional budgets allowed for release time for faculty to infuse new ideas into existing courses. For example, several faculty members at one institution contemplated how to use a collaborative teaching style to encourage student participation. Another institution took additional steps to put these ideas into practice by allowing students to devise the curriculum and deliver content.

Another example of the creativity exhibited by faculty was an interdisciplinary course in biology and chemistry created by two professors. By blending these two disciplines, students were able to make stronger connections between each kind of science and thus enhance their understanding of both. When interviewed, the professors were excited not only by the opportunity to collaborate but also by the opportunity to try new ways of teaching traditional material.

Faculty at TCUs used their opportunity to increase the degree to which the STEM curriculum reflected Native American perspectives. Because of a holistic world view in many Native American traditions, TCUs favor a pedagogy that emphasizes the teaching of systems first, and then the elements that compose those systems.

Institutions also hired new faculty during this phase. According to Systemic Research, Inc.'s, 2004 figures, underrepresented STEM faculty—Black, Asian/Pacific Islander, Hispanic, and Native American—at MIE institutions[7] increased by 32 percent between the 1994–95 and 2003–04 academic years. That increase was higher than the 28 percent total increase in STEM faculty at these institutions.

Student Development

The impact on students during the distribution of the initial investment is evident in the numerous scholarships that several institutions provided. Several students explained how the MIE scholarships they received kept them in school and able to maintain focus on

[7]Oglala Lakota College and Sitting Bull College were the only two members of the Oyate Consortium that had data available. Therefore, seven institutions were used here based on the availability of trend data.

completing their degrees. Otherwise, as many of those same students asserted, they would have had to work part time. Their sentiments were echoed across the institutions that offered large scholarships—validating the notion that keeping students on campus, and engaged, supports retention.

Precollege Activities [K–12]

While most of the strategies that are funded during the distribution phase involve on-campus activities, institutions also initiated and supported a set of precollege activities. One campus has invited local K–12 teachers and students to view poster sessions held by undergraduates. Other institutions have organized summer bridge programs to try to spark interest in STEM careers. Precollege activities help align expectations between K–12 and higher education. These programs also expose STEM careers to students who may not otherwise be made aware of the options, thus moving more students into the STEM pipeline.

Phase 3: Integration

The integration phase begins when initial student outcomes are realized. As MIE institutions engaged in faculty development, physical infrastructure construction and renovation, and precollege/K–12 activities, the impact on students was evident. For instance, during the distribution phase, institutions provided technology, equipment, and furniture that were intended to promote collaborative learning within classrooms and laboratories. During the integration phase, the collaboration actually took place. Similarly, after several institutions used the distribution of resources to create new academic centers, students, faculty, and staff used these facilities to integrate mentoring, tutoring, and group learning sessions.

STUDENT PROFILE

Reagan Higgins, Xavier University

Reagan Higgins is a former MIE student continuing her STEM education in graduate school.

"Being part of the MIE program also made me more marketable when applying to graduate school. It showed the department/institution that I have some needed skills and that I have been exposed to research. I presented my MIE research at my current graduate school while I was as a junior at Xavier. I didn't think that I would be here [at the University of Nebraska–Lincoln] but I am. Also, MIE affords students the opportunity to make campus visits. Although the reason for the trip was to present my findings, I met my current advisers."

Reagan Higgins, 2006

STUDENT PROFILE

Ebony K. O'Neal, Spelman College *(far right in photo)*

Ebony K. O'Neal contributes her current success to both MIE and Spellman College. "As a second year MIE research intern, the program has contributed to my matriculation as both a 'minority' and 'female,' practicing within mathematics and the sciences, destined for graduate school and continued education.

Spelman College, 2005

"Through my research assignment, I traveled as part of a team of five others to Osaka, Japan (July 11–19, 2005). [It was] the first all-female team, the first HBCU, and the only U.S. undergraduate institution to qualify to participate in the global computing machinery and robotics research competition, RoboCup. Spelman's robotic team, SpelBots, short for 'Spelman Robotics,' was motivated to indeed inspire other young women to pursue educational research and explore careers in computer science and robotics."

Changes in STEM enrollment and graduation also were marked during the integration phase. Though all the causes for broad institutional change cannot be isolated, compared with nationwide enrollment and graduation, the numbers at MIE institutions were noticeably larger. Between academic years 1994–95 and 2002–03, enrollment in STEM majors increased by 16 percent nationwide. But at the MIE institutions, enrollment in STEM majors increased by 24 percent (Systemic Research, Inc. 2004).

Likewise, the difference between the STEM degree total nationwide and that of the MIE institutions was substantial. Between academic years 1993–94 and 2001–02, the total number of STEM degrees conferred nationwide rose 19 percent while they rose by 46 percent at MIE institutions (Hill 2000).

Data also suggest that MIE graduates continue to move through the STEM pipeline. In the 2000–01 academic year, MIE institutions graduated 754[8] students. Of that number, 339 (or 45 percent) were admitted to graduate programs. Another 115[9] moved straight into STEM careers. Thus, in the 2000–01 academic year, around 60 percent of all MIE STEM students were retained in the pipeline (Systemic Research, Inc. 2004). These positive trends, like those described earlier, strongly suggest that the MIE investment affected these outcomes. On the other hand, factors such as concurrent grants, preexisting institutional commitments to minority student success, and changes in admission criteria also could have been influential.

[8] Oglala Lakota College, Spelman College, The University of Texas at El Paso, Universidad Metropolitana, Xavier University of Louisiana

[9] Bowie State University and Spelman College

Phase 4: Production

As the integration phase describes the preparation of new students, faculty, and other professionals to enter STEM fields, the production phase describes the results of those efforts. The scientific discoveries, practical lessons learned from the MIE program, strategies to develop STEM at other institutions, and instructive evaluation describe the categories of the new knowledge generated.

New Science

Though the institution once focused on majors related to teaching and learning, Universidad Metropolitana now produces students pursuing research in fields such as "large-scale antibiotic misuse," food microbiology, and atmospheric science. Meanwhile the faculty at Universidad Metropolitana has been published on a wide range of topics, including "Luminescent Nanometric Particles of Silicon as a Bacterial Probe" and "Comparative Study of the Growth Curves of [E.Coli] Bacteria."

Similarly Bowie State University linked together MIE computer science students and numerous Macintosh computers to create one of the two hundred fastest supercomputers in the world (University of Mannheim and University of Tennessee 2006).

Evaluation and Analysis

Through the efforts of Systemic Research, Inc., and evaluators on MIE campuses, institutions had the opportunity to look at enrollment, retention, and graduation data across the years. By looking at those data, they could ascertain in some circumstances which courses

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To accommodate the work and family schedules of its students, Oglala used Blackboard's distance learning technology to offer many courses online.

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were giving students the most trouble or look at the years in which retention challenges were the strongest. The institutions could then devise new strategies or redirect programmatic emphases to improve success.

Strategies Identified

As each institution developed a better sense of what was required to meet its broader objectives, it employed new strategies. The data and feedback that the MIE institutions received from evaluators also influenced the employment of new strategies. This continual evolution of the program contributes to MIE's comprehensive nature. For instance, as mentioned earlier, UTEP made the infrastructure intended for STEM students available to liberal arts students throughout the campus once it determined that the expansion would enhance on-campus relations among departments.

Not only were additional strategies folded into implementation the next year but also MIE institutions shared strategies with each other. For example, to accommodate the work and family schedules of its students, Oglala used Blackboard's distance learning technology to offer many courses online. The faculty at Oglala reported that the asynchronous nature of online learning combined with the ability to receive content from remote locations increased course accessibility significantly. According to the chair of Oglala's Information Technology Department, those online courses were most likely to be accessed between 10 p.m. and 2 a.m. A visit to the Lakota reservation, on which Oglala is located, revealed that this strategy overcame the challenges posed not only by the limitation of time but also by distance.

Lessons Learned from the PIs

After 11 years the PIs have collected many practical lessons about how to implement and sustain large projects. In the next phase of MIE, the PIs are preparing ways to share those lessons with other institutions that are committed to providing STEM education to students of color. Among those lessons already shared is that gaining faculty support from the beginning of a project—while financial resources are being allocated—is easier than doing it later. While gaining such support can be a significant challenge, one PI was successful by describing the evolving MIE efforts in terms that the faculty would

STUDENT PROFILE

The research that Azzari Caillier Jarrett and Fabio Sanchez conduct exemplifies the reinvestment stage. Their work not only represents the development of institutional models for STEM education but also constitutes innovative research that may become beneficial to the general public.

Azzari Caillier Jarrett, Xavier University

Azzari Caillier Jarrett, 2006

"While at Xavier University of Louisiana, [through the MIE fellows program] I was able to publish and present two papers on my research work in natural language processing and artificial intelligence at national conferences. I also had the chance to experience research in an industrial setting with internships at IBM and T.J. Watson Research Center."

"My current research is based in the field of human computer interaction and knowledge management. I am interested in how users deal with reading, organizing, and keeping track of information online. An information overlap problem exists when users cannot find the quality of information in the quantity of information available. My research will help users interact with information online by applying content analysis and social information to help navigate the glut of information."

Fabio Sanchez, Universidad Metropolitana

Fabio Sanchez, 2006

"I work on the modeling of infectious diseases, specifically vector-borne diseases such as dengue fever, malaria, leishmaniasis, and West Nile virus. Using mathematical tools (nonlinear differential equations, partial differential equations, and statistical methods) we are able to study the dynamics of the diseases and hope to get some insight in finding control measures."

Institute for Higher Education Policy, 2005

Institute for Higher Education Policy, 2005

Top: NSF program director for MIE, David Temple; Bottom: NASA program officer for MIE, Carl Person

appreciate. For instance, to encourage faculty to participate in seminars on collaborative teaching methods they said, "If you use these methods, you will not only be a more effective teacher, you will have to spend less time preparing for classes because students will require less classroom teaching—their effectiveness and efficiency goes up."

PIs also learned how important it was to be champions of the "MIE cause" on campus. When other leadership was transient and institutional priorities shifted, it was up to the PIs to maintain their own programmatic missions and follow through with their objectives. This is where the camaraderie that developed between the PIs and consistent support from the NSF and NASA program officers had an impact. Periodic meetings among the aggregate MIE group and open communication filled the gap when on-campus support was not apparent.

Phase 5: Reinvestment

The new knowledge generated by all those involved with MIE becomes intellectual capital that NSF and NASA can invest in a larger number of institutions. Through IHEP's dissemination efforts and other convening activities, more institutions are learning from the strategies and lessons from 11 years of successful MIE implementation. The reinvestment phase defines the process of collecting the knowledge and making it available to others. A series of conferences, seminars, and meetings has been organized to share information about the MIE model. Following are descriptions of those ongoing efforts.

The National Science Foundation's Joint Annual Meeting (April 25–27, 2005)

Convened under the division of NSF's Directorate for Education and Human Resources, the programs funded under that division present the status and results of their activities. The audience includes other NSF staff and other NSF grantees. During the 2005 joint annual meeting, IHEP, AIR, Systemic Research, Inc., and the MIE PIs all reported on their progress. The convening of all MIE partners also provided another opportunity to share knowledge and help their colleagues develop joint products.

The Institute for Higher Education Policy's National Dissemination Conference (June 23–24, 2005)

On June 23 and 24, 2005, IHEP in collaboration with NSF, NASA, and the three organizations that form the Alliance for Equity in Higher Education—the American Indian Higher Education Consortium, the Hispanic Association of Colleges and Universities, and the National Association for Equal Opportunity in Higher Education—hosted a national conference to share how the MIE model can improve STEM capacity at MSIs.

Held in Washington, D.C., the conference was attended by about seventy-five people representing about thirty-five MSIs. The representatives were faculty, deans, and other administrators in the STEM fields. The meeting was successful on three levels: (1) attracting a strong core group of institutions that expressed interest in implementing new STEM-building strategies; (2) sparking conversation about lessons learned and the practicality of strategies presented; and (3) demonstrating again the value in collaboration across communities, government agencies, and institutions.

The conference was interactive with presenters who explained the MIE model to the attendees and then probed the extent to which participants could apply the MIE model on their own campuses.

After the presentation of the aggregate MIE model, the MIE PIs described how they implemented different aspects of the MIE strategies on their own campuses. They focused on student development, faculty development, and physical infrastructure development. Those presentations incorporated points from their original syntheses of MIE implementation strategies.

Systemic Research, Inc.'s Tenth Annual MIE Self-Evaluation Template (August 18, 2005)

This meeting was the tenth in a series of meetings sponsored by Systemic Research, Inc., to help MIE institutions collect the data that Systemic Research, Inc., aggregates and analyzes. At this meeting, Systemic Research, Inc.'s President Jason Kim discussed their new format for data reporting. Current data would be reported by each institution and collected according to the institution's different student populations and program variations. The method of collection uses Web-based forms and Microsoft Excel. PIs and other MIE staff attended the training.

Also presented were the latest statistics (2003–04) that had been gathered and analyzed the previous year. Enrollment, degrees conferred, retention rates, and faculty employment were all presented and disaggregated by categories such as major and ethnicity.

The self-evaluation template for 2005–06 has quantitative and qualitative components. The quantitative part has eight sections:

1. Institution and MIE profile
2. Budget profile
3. Academic resources profile
4. Student enrollment and degrees conferred
5. Student MIE activity summary
6. Faculty demographics
7. STEM faculty activities
8. STEM department profiles and progress

The qualitative part asks questions aligned with 11 indicators in the 2005 *MIE Fact Book*. Those questions ask for MIE influence, activities, or achievements corresponding to those general topics and indicators:

- MIE program synopses and model diagrams
- MIE milestones and student success stories
- Institutional (data) profiles for academic year 2004–05
- Key indicator highlights
- Undergraduate STEM enrollment
- STEM enrollment by major
- STEM degrees conferred
- STEM degrees conferred by major
- Enrollment and graduation by individual major
- Undergraduate STEM retention
- STEM student achievement and success stories
- STEM faculty demographics
- Faculty research and activities supported by MIE
- Collaborative and precollege activities
- Research and computing facilities
- Institutionalized MIE program components
- Dissemination of MIE model

Once collected and analyzed, these data will be made available through the NSF, Systemic Research, Inc., and IHEP Web sites and additional publications.

The McKenzie Group/AIR Expanding the K–12 Pool of Potential STEM Graduates National Workshop (April 7–8, 2005)

As the MIE partners continued to look at program results and implications for the future, the recurring issue of students in the STEM pipeline became more salient. And given the success of the partners' collective efforts, momentum developed to expand the pool of students who can take advantage of the MIE knowledge that is being infused into MSIs. The result was a larger partnership among representatives of MIE, nearby school districts, seasoned directors of successful K–16 programs, and notable experts in education.

The specific objectives of the two-day workshop included (1) discussing the disappointments in K–16 minority education with a focus on factors that inhibit rigorous course taking in the math and science disciplines necessary for STEM enrollment in college; (2) sharing strategies used by MIEs and other national initiatives to strengthen K–12 preparation and increase college enrollment in STEM fields; and (3) developing an action plan for the format and substance of a follow-up meeting designed to encourage MIE institutions to develop K–16 partnership strategies to expand the K–12 pool of potential STEM graduates.

The follow-up meeting was held October 10–11, 2005, as the culmination of the planning meeting. This subsequent two-day workshop built upon the previous objectives. The new set of objectives included the following:

- Learn from exemplary STEM partnerships and programs targeting young females and/or minorities.

- Develop a strategic action plan to be enacted over the 2005–06 academic year that will include a generic but detailed funding proposal outline for a targeted K–16 partnership.
- Identify immediate next steps to establish the proposed targeted K–16 partnership.
- Identify and share implementation support needs with the NSF/MIE program director and AIR technical assistance team.

The group that came together for this second workshop was sorted into teams based on MIE locations. Each team was composed of a MIE PI, an additional MIE faculty or staff member, representatives from local school districts near the MIE institutions, and a consultant whose job was to facilitate the initial meeting.


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Part III: Replication

If the ability to replicate experiments is governed by the existence of the same resources, conditions, and procedures in future attempts, this next section will help institutions move toward the replication of the MIE program's successes.[10] Resources that need to be tapped are identified in the description of those who made the model work on individual campuses and some of the ways they made it work. The conditions that need to be present are expressed in policy recommendations on the institutional, state, and federal levels. Long after the publication of this report, the MIE PIs intend to continue this work by providing direct assistance to institutions that endeavor to implement the MIE program on their own campuses.

Who made the program work?

The primary source for implementation of the MIE program at each institution was its people. While the PIs helped secure funding and served as the link between their institutions and the NSF or NASA, the faculty, staff, administration, and students all played a vital role in each enterprise. Following is a discussion of the roles played by those involved with the MIE program.

Presidents

As with most initiatives, support from the top institutional leader can ensure thorough implementation and sustainability. MIE institutions were no exception. While each institution fully integrated MIE into its operations over the program's 11 years, the rate of implementation and the consistency of institutional support were affected by the commitment from each institution's president.

Such commitment came from explicit or implicit messages. At one institution, the president declared support for STEM education and the MIE program by mentioning it in the "President's Message" Web page. It was clear throughout that institution that the MIE programmatic priorities were also the priorities of the president. The cross-disciplinary and comprehensive nature of MIE operations at that institution reflects leadership commitment.

Another institution saw leadership commitment vary between explicit and implicit messages. In the beginning, the liberal arts community at the institution was resistant to MIE implementation. The resistance seemed to be fueled by to two factors. One, there had been several changes in leadership, thus, there was not a consistent rationale for STEM investment that could withstand inquiry. Two, the support expressed by the leaders who were in place was implicit and lukewarm. In later years, the institution gained a new president who was much more explicit and vocal about the commitment to STEM. To match that support, the same president took a political risk to adjust the institution's budget for one of the MIE/STEM disciplines to fund needed infrastructure development.

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[10]For this section, examples of resources and conditions are drawn from interviews or observations during site visits conducted by IHEP and AIR staff during fall 2004.

Principal Investigators

PIs were the change agents on their respective campuses. To build their versions of the MIE model, they often had to change the ways their institutions operated. In some cases change meant getting faculty to change how they taught. In other cases change meant changing how certain courses were delivered. But each PI has a story to tell about how he or she implemented change.

One implementation strategy shared by a PI required first going to faculty in departments that were most likely to be supportive of MIE objectives in order to build momentum. Then that momentum was used to engage department heads and deans. This approach was neither "top-down" nor "bottom-up," but it was described as a "cross-coalition" approach.

Another implementation strategy was to practice a communication style that could succinctly and passionately convey the benefits of MIE to faculty and administrators. For each potential collaborator, the PI carefully thought out the specific professional benefits that MIE would bring to that individual. For example, the benefits for faculty could include release time, an invigorated curriculum, and consequently an engaged group of students. For deans, the benefits could include greater research output, more institutional resources, and increased capacity to attract new faculty.

PIs also understood how to make all the components of the model coexist and work together. At several institutions, MIE was leveraged not only to obtain additional funding but also to connect various STEM activities to their institution's strategic plan. For example, at one MIE it was possible to restructure preexisting study circles and undergraduate research and faculty development activities to support broader MIE goals—even though projects were funded through various grants.

Faculty

Faculties were key to translating the passion for MIE objectives into everyday interactions with students. For instance, faculty members could spark student interest to pursue research topics and to consider STEM careers.

The faculty also played a pivotal role in creating future faculty and researchers in STEM fields. By serving as examples for the students, faculty members could either attract students to MIE or repel them from the profession on the basis of the quality of their experiences together. To provide an even stronger link between students and faculty, one institution created a new "scholar-teacher" position. That position was filled by graduate students who had been in the MIE program and could continue their postdoctoral research at their alma mater. But in return for the research support that the institution provided, the scholar-teacher would also serve as an instructor within the same STEM/MIE disciplines. Students could then hear firsthand how one of their own had gone on to greater success after graduation.

MIE-specific staff

The titles "assistant PI," "retention coordinator," and "program associate" all describe specialists who were hired to implement MIE objectives. Staff members filling these positions were responsible for maintaining constant contact with the students. Staff members telephoned students if they missed class and made sure that students took advantage of the

STUDENT PROFILE

Ché Smith, Spelman College

Ché Smith, 2006

The following account from Ché Smith, a MIE graduate from Spelman College, speaks to the importance of the people involved in facilitating the MIE model, including both the influence of her advisor and her own role in advising younger students. She is pictured above during her final poster presentation.

"The MIE program afforded me the unique opportunity to identify a research advisor in the Mathematics Department. In choosing Dr. Nagambal Shah, I embarked on an important study that investigated the impact of airplane emissions on air quality in Atlanta. I analyzed air quality data from metropolitan Atlanta monitoring sites in the aftermath of the 9/11 terrorist attacks to determine if the subsequent shutdown of Atlanta's airport affected the presence of certain toxic chemicals in ambient air. I presented our findings at several national and local conferences, research symposia, and government agencies, [where] the project was well received.

"These accomplishments demonstrate the benefits of not only developing good research skills but also honing my ability to communicate my work and its importance to others. Another important aspect of Spelman's MIE program is its mentoring component, through which I was able to advise young female students and communicate to them the importance of continuing the learning process by attending college and pursuing careers and opportunities in research.

"I look forward to the abundant opportunities to engage in research that will benefit the lives of many. I hope to make an indelible mark on the world as a leader and scholar in public health."

full range of the institution's services. Staff members provided the supportive infrastructure within a highly competitive environment so that students of color could excel.

Students

While students were an obvious beneficiary of the program, certain students also became active workers or "apprentices" for the program. At one particular institution, students were managing the tutoring component. At another institution, an "apprentice" created a Web-based communication tool to facilitate research collaboration between MIE faculty and students. At another, student-led instruction fostered greater classroom engagement.

What are some of the institutional conditions needed for MIE to work?

MIE's impact on STEM education broadly at the participating institutions has been impressive. Yet, these outcomes were achieved in part because of systemic investment strategies that took place at each MIE, using the institution's own unique context, community, and student profile as the basis for designing and delivering a wide range of services. These strategies have important implications for policy development at institutions wishing to emulate the MIE models of success.

Implementation at MIE institutions is multifaceted and long term

Often practitioners seek to increase student success by patching together a set of strategies that may or may not be tied to the institution's mission. However, the MIE institutions took a comprehensive approach to increasing STEM capacity and implemented a series of strategies over an 11-year period. During a longer period of time, there is a greater likelihood that the strategies will be institutionalized.

Substantial resources are invested in data-gathering and analyses

The investment MIE institutions have put into data collection and analysis has paid dividends in several areas. It has provided the basis for claims of student and overall program success. It shows the MIE institutions where their greatest success has been in recruitment, retention, and graduation. It also highlights areas of growth. Data on the high failure rates of incoming math students prompted UTEP to break its math classes into modules and take advantage of the Circles for Learning and Entering Students (CircLES) clusters to deliver math content to smaller study groups.

Students are encouraged to collaborate

Retention literature has established academic engagement as an effective strategy (Chickering and Gamson 1987; Tinto 1993). By encouraging students to collaborate on projects, faculty can initiate academic engagement. This strategy can be particularly useful for students of color given concerns regarding disparate academic preparation. Universidad Metropolitana and UTEP provided a substantial number of strategies to achieve such engagement. The use of collaborative technology and furniture, and peer tutoring in Universidad Metropolitana's Summer Bridge Program, Science Support Center, and Summer Adventure program, and in UTEP's CircLES all bring students together and support success in STEM disciplines.

Context matters

Each of these institutions already has a substantial number of students of color, faculty, and administrators representing the communities within the scope of their missions, and the message promoting minority student success is unambiguous. Such messages are conveyed on the institutions' Web sites and promoted by their presidents. Other institutions can provide a similarly consistent message by first looking at their own Web sites, practices, and populations, then bringing those messages in line with their mission statements. Other institutions with identifiable numbers of students of color can achieve the MIE's success, but it will take a long-term commitment and a cohesive vision. That commitment and vision will require government policy action as well.

What state policies can contribute to replication?

While individual institutions have the greatest influence over the outcomes achieved by MIE activities, states can improve the context for success. For instance, they can target the same areas of MIE's impact for a similar investment. States can also promote success by providing a more holistic focus for state educational systems. Other examples of efforts that could be undertaken by states include the following:

Fund multiyear capacity building efforts

NSF and NASA funded the MIE institutions over an 11-year period because they knew that it would take time to build capacity. The buildings, lab equipment, and faculty positions that MIE funding provided took several years to be put into place. If the funding streams had been cut off abruptly, as when state priorities change between administrations, the burden of completion could have put large-scale projects in jeopardy. Thus, states must take a similar long-term view and invest in STEM education as an investment in success over several state-funding cycles, rather than as an initiative that can be addressed in one legislative cycle or even during the tenure of single governor.

Support research within the mission of MSIs

While virtually every state has a flagship university or institution that it favors to receive the bulk of research funding, this narrow strategy will require reexamination in light of the lessons learned through MIE and other initiatives. If states are serious about producing more students of color in STEM fields, those states must ensure that their MSIs (if they do not receive adequate state funding otherwise) are allowed to pursue the

If states are serious about producing more students of color in STEM fields, those states must ensure that their MSIs are allowed to pursue the funding needed to support research and STEM capacity.

funding needed to support research and STEM capacity. This means rewriting state-funding formulas and performance-funding strategies that reward activities at a limited number of schools to favor funding mechanisms that encourage broader investment in STEM capacity building. State leaders may also support MSIs by making it clear to peer institutions that support for the growth of research capacity within their MSIs is a statewide priority.

Review K–16 policy options

Establishing precollege programs and other K–12 relationship building is an effective component of MIE. States can expand those efforts by examining how future STEM students may work their way through the educational systems. This means looking hard at the quality of teacher education in STEM fields for the early grades. It also means ensuring that the quality of STEM curricula is consistent across educational districts. In addition, it means looking at whether the criteria needed for completion of science courses in K–12 correlates with the entry requirements for college STEM students.

Some states like Maryland, Texas, Georgia, and Virginia have already formed K–16 consortia to address these broader systemic issues (Venezia, Kirst and Antonio 2003). Others can simply provide the financial support for institutions such as UTEP and Universidad Metropolitana that have initiated K–12 partnerships with surrounding schools on their own.

What conditions at the federal level would help replication?

As suggested earlier, federal policy related to future STEM workforce needs will gain the broadest appeal when those policies address the quantity, quality, and diversity of the workforce. The following recommendations take those issues into account while also considering other fiscal and strategic concerns:

Increase funding for community research grants

MIE has shown that as students benefit from research training in STEM, they often use the new insights to address community improvement issues. MIE's PIs also stressed the importance of research as a key component of program success. The increase for funding can be provided through federal agencies or in partnership with corporations that engage in substantial research and development.

Expand funding for minority-serving graduate institutions

With the significant investment in curriculum development, each MIE institution was able to expand its course offerings in the STEM fields. Oglala Lakota College went from having no STEM courses to offering associate's degrees in those areas to recently offering bachelor's degrees in STEM fields. Sustained support for MSI curriculum development will lead to additional institutions offering graduate degrees and additional opportunities in the supportive MSI environment for graduate-level students in STEM fields.

Provide more funding for research at the community college level

About half of the nation's students of color start their postsecondary education at a community college (U.S. Department of Education, National Center for Education Statistics 2005). Therefore, more resources in the STEM fields will be directed in a manner that can support potential bachelor's degree and graduate students. NSF's Advanced Technological Education Program captures some of these potential students. Similar efforts can ensure that students who start in technical programs have the option of moving into extended four-year programs at MSIs.

About half of the nation's students of color start their postsecondary education at a community college. Therefore, more resources in the STEM fields should be directed in a manner that can support potential bachelor's degree and graduate students.

President Bush's American Competitiveness Initiative

Mentioned earlier, the American Competitiveness Initiative calls for the training of new teachers and instructors in STEM. With the number of teachers who currently have responsibility for teaching in these areas but lack the training, components of the initiative will make a difference. However, the initiative will pay even closer attention to school districts with high concentrations of students of color or low-income students. Those areas are the least likely to have teachers with adequate training in STEM subjects (Peske and Haycock 2006; U.S. Department of Education, National Center for Education Statistics 2000).

Continue to bolster funding for Title III and Title V

The Alliance for Equity in Higher Education has continued to advocate for increased funding of Title III and Title V of the Higher Education Act. The Alliance member organizations—the American Indian Higher Education Consortium, the Hispanic Association of Colleges and Universities, and the National Association for Equal Opportunity in Higher Education—have taken the position that, with the substantial increases in student enrollment at MSIs, level funding would amount to a step backward.

Conclusion

The MIE program is a story worth being told. Its origins coincide with the nation's growing need to increase national competitiveness, and they provide a template for how the federal government, states, and individual institutions can contribute to solutions. By building upon the practical lessons that MIE provides and rallying the nation to foster optimum conditions, the future STEM workforce can be produced at more MSIs or other institutions that also are oriented toward minority student success.

A final piece of the story, however, that has not been told is how this 11-year-long program also built a network of people. MIE was initially conceptualized jointly between two NSF departments that had not worked together previously. That spirit of cooperation then emanated beyond NSF's walls and brought in NASA as a program funding partner. Once the program arrived at each campus, coordination among all the institution's facets had to be fostered. Most significantly, the MIE process also linked the three underrepresented MSI communities together to form an ongoing and substantive partnership. And at a time when religious, political, and philosophical differences frustrate important public policy debates, MIE also shows how collaboration among agencies, communities, and institutions can affect our capacity as a nation to be economically competitive, socially cohesive, and secure.

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MIE: The Institutions

Bowie State University

Established in 1865, Bowie State University is the oldest historically black institution of higher learning in Maryland and is one of the oldest in the nation. The institution evolved from a normal school into a comprehensive university that offers a wide array of undergraduate, graduate, and professional programs. Bowie State University serves a diverse student population, providing educational opportunities that will enable students to function in a highly technological and interdependent world. The university continues to honor its heritage of providing access to higher education for underrepresented populations and is committed to African Americans. Bowie State University remains a leader in the graduation of African Americans in teacher education and technological fields. Its total enrollment is approximately 5,148 students, 1,393 of whom are in the graduate school.

MIE Profile

Bowie State University's MIE initiative is focused on giving its students access to faculty role models from similar ethnic backgrounds, peer mentors and learning teams, an exciting and high-quality curriculum, and faculty mentors with whom they can work on research projects and get paid for doing so. Its goals are to dramatically improve enrollment, retention, and graduation rates while infusing the institution with the latest information technology. Seven education reform strategies are being pursued: outreach, student retention, research, linkages and collaboration, infrastructure and human resource component, education reform, and self-assessment and evaluation.
http://www.bowiestate.edu/about/default.asp
***MIE Fact Book,* II-3–II-5**

Spelman College

Spelman College is the oldest historically black college for women, founded in 1881. Its historic campus is just minutes west of downtown Atlanta. With more than 2,100 students from 41 states and 15 foreign countries, Spelman offers majors in 26 fields, including special pre-law and pre-medical sequences. Spelman College has a national reputation for promoting academic excellence and a rich history of producing black women leaders. The college is ranked on *U.S. News and World Report's* list of Top 75 Liberal Arts Colleges, 2005 edition.

MIE Profile

Spelman has prepared more than six generations of African Americans to reach the highest levels of academic, community, and professional achievement. Sponsored by NASA, the MIE program enhances Spelman's impressive record of preparing women for STEM careers.

The program provides students with research opportunities, strengthens Spelman's STEM infrastructure, supports curriculum and teaching reforms, and establishes early intervention activities for STEM students.
http://www.spelman.edu/about_us/glance/
***MIE Fact Book,* II-23–II-24**

Universidad Metropolitana

Universidad Metropolitana is home to approximately 8,870 undergraduate and graduate students who are mainly underrepresented low-income students of color from the metropolitan San Juan area in Puerto Rico. Universidad Metropolitana's educational policies are based on the belief that higher education should be available to every individual. It is strongly committed to a democratic way of life, human equality, and respect for human dignity. One of the university's basic tenets is to offer academic programs reflecting changes in technology, economic trends, population fluctuations, and job market tendencies that will help its graduates obtain employment and foster productive contributions to society in general.

MIE Profile

The major goal of the cooperative agreement with NSF was to lay out the foundation for the transformation of Universidad Metropolitana into a major producer of bachelor of science degrees in Puerto Rico. During Phase I of the Cooperative Agreement with NSF (1995–2000), several major accomplishments were achieved, including constructing undergraduate teaching and research facilities, hiring new faculty, and offering six new bachelor of science degrees: chemistry, environmental science, cellular and molecular biology, applied mathematics, applied physics, and tropical and natural resources. During Phase II (initiated October 1, 2002), three research laboratories were created and an undergraduate research program, with research mentors from the Department of Science and Technology, was initiated. MIE has also aided in the creation of summer internships, bridge programs to graduate schools, and budgetary changes to further support STEM studies.
http://www.universities.com/Schools/U/Universidad_Metropolitana.asp
***MIE Fact Book,* II-43–II-45**

The University of Texas at El Paso

UTEP is located in El Paso, a city of 800,000 at the westernmost tip of the state, on the border with Mexico. UTEP's student population is more than 67 percent Mexican American, and another 9 percent of its students come from Mexico. These student demographics, together with UTEP's traditional strengths in science and engineering, give this university a special niche in U.S. higher education. UTEP's faculty members are highly committed to student learning, and they actively involve students, both graduate and undergraduate, in their research.

MIE Profile

The UTEP MIE initiative supports five major components that promote change in institutional culture with the ultimate goal of improving the STEM educational system. UTEP's MIE components are the following:

- Circles for Learning and Entering Students—A mandatory orientation, advising, and first-year academic program for all incoming students who have indicated an interest in pursuing a STEM career.
- The Academic Center for Engineers and Scientists—A student support center that provides tutoring, study resources, general advising, and other key services for the academic success of a largely commuter STEM student population.
- The Center for Effective Teaching and Learning—A faculty development center that promotes scholarly teaching and educational research across campus.
- The Research Experiences for Undergraduates Program—A major component of an effort to track talented undergraduates into graduate school by enriching their on-campus experiences and encouraging them to pursue off-campus research opportunities and professional internships.
- STEM Curriculum Reform—An effort that encourages faculty to adopt active learning strategies in the classroom, and revamp course content and student performance assessment techniques.

http://www.utep.edu/aboututep/
***MIE Fact Book,* II-67–II-68**

Xavier University of Louisiana

Xavier University of Louisiana is Catholic and historically black. The ultimate purpose of the university is the promotion of a more just and humane society. To this end, Xavier prepares its students to assume roles of leadership and service in society.

According to the U.S. Department of Education, Xavier continues to rank first nationally in the number of African American students earning undergraduate degrees in biology, physics, and the physical sciences overall. Xavier has been especially successful in educating health professionals. The College of Pharmacy is first in the nation in the number of Doctor of Pharmacy degrees awarded to African Americans. In pre-medical education, Xavier is first in the nation in placing African American students into medical schools. The 77 percent acceptance rate of Xavier graduates by medical schools is almost twice the national average, and 92 percent of those who enter medical schools complete their degree programs.

MIE Profile

Through the MIE program, the university has sought to strengthen that tradition by developing an infrastructure that will support a substantially larger population of Xavier students who are motivated and prepared to pursue graduate studies in their chosen majors. Major components of the MIE program have included substantial renovations to campus facilities such as the establishment of resource and mentoring centers, and additional teaching and search laboratories. There has also been a significant upgrade in the quality of, and access to, computing and electronic communications systems for faculty and students. Additionally, important developments have taken place in instructional strategies, materials and curricula, and administrative processes that support these efforts.

http://www.xula.edu/Aboutxavier.html
***MIE Fact Book,* II-85–II-86**

Oyate Consortium

The Oyate Consortium consists of five Lakota reservation colleges and universities (Oglala Lakota College, Sisseton-Wahpeton College, Sitting Bull College, and Sinte Gleska University). The initial MIE grant provided substantial network infrastructure, physical infrastructure, personnel infrastructure, and course and curriculum development aimed toward the development of science, mathematics, engineering, and technical education capacity at Native American colleges. This award continues these activities, building on existing infrastructure to develop new information. Additionally, methods of institutionalization of the MIE accomplishments will be pursued, including the development of an endowment for STEM capacity and the means for providing housing for faculty and, perhaps, for students at the campus sites.
***MIE Fact Book,* II-104**

Oglala Lakota College

From its inception in 1971, Oglala Lakota College's mission has been to provide educational credentials to students so that they can compete for employment opportunities on the Pine Ridge Indian Reservation, located in southwest South Dakota. As a result of having a college on the reservation, Lakota people are now employed in teaching, nursing, human services, business, computer, and vocational educational positions on the reservation.

Oglala was one of the first tribally controlled colleges in the United States. As such, it is sanctioned by an Indian tribe, it is governed by an Indian tribe, its governing body is made up of tribal members, and it works to meet the needs of reservation people in their pursuit of higher education. From its initial status as a community college, Oglala has grown to offer bachelor's degrees, a master's degree, and certificates and associate's degrees. Enrollment has grown to 1,400 students.
http://www.olc.edu/message
***MIE Fact Book,* II-103**

Sisseton-Wahpeton College

Sisseton-Wahpeton College is a dynamic learning environment whose heart is student achievement. The college is located in northeast South Dakota. With approximately 245 students, 78 percent of whom are Native American, Sisseton-Wahpeton confers 24 associate's degrees. Sisseton-Wahpeton's educational mission strives to help students maintain Dakota culture, contribute to the community as socially responsible individuals, celebrate creativity, and challenge them mentally through a strong academic program.
http://www.swc.tc/welcome.htm
***MIE Fact Book,* II-121**

Sitting Bull College

Founded in 1973 and located in Fort Yates, ND, Sitting Bull College is an academic and technical institution committed to improving the levels of education and training, and economic and social development of the people it serves while promoting responsible behavior consistent with the Lakota/Dakota culture and language. All people grow to their full potential by knowing and understanding their beautiful and profound cultural heritage; therefore, Dakota/Lakota culture will permeate a holistic educational process,

which will permit all people to develop in balance from the elders' teachings to live in the present world. Total enrollment is approximately 139 students, and nearly 95 percent are Native American students.
http://www.sittingbull.edu/aboutus/vision/
***MIE Fact Book 2002,* II-139**

Sinte Gleska University

The very essence of Sinte Gleska University stems from its location on the Rosebud Reservation. From the beginning, the founders of Sinte Gleska University sought to establish a tribal higher education institution based on the philosophy of tribal control and tribal self-determination. An important premise of this philosophy was to effect change for the Rosebud Sioux tribal nation. Today, in the 21st century, Sinte Gleska University remains committed to its earliest purposes: to preserve and teach Lakota culture, history, and language to promote innovative and effective strategies to address the myriad social and economic concerns confronting the Sicangu Lakota Oyate. Total enrollment is approximately 1,181 undergraduate students, 60 percent of whom are female, and 70 percent of whom are Native American.
http://www.sinte.edu/mesgfromPres.htm
***MIE Fact Book 2002,* II-155**

MIE Institutionalization Efforts

The following excerpts from Systemic Research, Inc.'s, *MIE Fact Book 2002* delineate the institutionalization efforts of the MIE schools to ensure the maintenance of funding and programs beyond the life of the original MIE grant.

Bowie State University

Institutionalized Component

The MIE model at Bowie State University, particularly those elements pertaining to retention, is in the process of being adopted throughout the university. The Summer Academy, Tutoring and Resource Center, Summer Internship Program, and other retention strategies are all being implemented as part of a university-wide expanded program. The responsibility for professional faculty and staff development has been delegated to the Center for Excellence for Teaching and Learning (CETL). The Office of Information Technology has assumed the responsibility of faculty and staff training in the area of information technology. The position of Assessment and Information System Coordinator has become the responsibility of the Office of Institutional Research (October 2000)

Leveraged Funding

The STEM domain has leveraged several projects that have resulted in additional funding: National Institutes of Health (Natural Sciences), NASA (Computer Science, Natural Sciences, and Mathematics), NSF (Computer Science), Honeywell Technology Solutions, Inc. (BSOCC), National Security Agency (Computer Science), and the U.S. Department of Education (Natural Sciences). Since academic year 1994–95, the dollar value of annual actively sponsored programs (grants and contracts in the STEM domain has increased six-fold to approximately $3M/year).

(*MIE Fact Book*, II-20)

Universidad Metropolitana

- Several bachelor of science degree programs were and still are being developed by the STEM faculty during Phases I and II of the MIE project. The original STEM program offers degrees in biology and computer science at the Department of Science and Technology were complemented with a full array of new bachelor of science degree programs in chemistry, environmental science, cellular molecular biology, natural tropical resources, applied mathematics, and applied physics. In 2003, an Environmental Health bachelor of science degree was implemented to enhance the biomedical area at Universidad Metropolitana. A new bachelor of science degree program in geographical information systems was also in place in the fall of 2003.
- The laboratory and research infrastructure of Universidad Metropolitana has been enhanced by the implementation of new research laboratories in computational chemistry, marine mammals, cellular molecular biology, computer science, applied physics, applied mathematics, and, in 2003, the new research facilities for environmental

toxicology at a cost of over $272K. The funding for this laboratory will be covered in part by the supplemental grant to the MIE project by the National Institute of Environmental Health Sciences.

- Policy changes in faculty contracts were implemented in the fall of 2002. New five-year contracts were awarded to young faculty with doctoral degrees.

(*MIE Fact Book,* II-62)

The University of Texas at El Paso

Institutionalized MIE Program Components

- Discussion and planning for the integration of the Circles for Learning and Entering Students other college programs are ongoing.
- Discussion and planning for institutional funding for ACES continues.
- Environmental science is an official degree-granting program in the Texas Higher Educational System.
- The Basic Engineering Program is a core curriculum for students interested in specializing in civil, industrial, mechanical or materials and metallurgical engineering.

The calculus-based physics course and lab, and the introduction to chemistry course with supplemental instruction and peer facilitators have been redesigned and will continue to be offered. The "modular" approach to pre-calculus has been institutionalized. The salaries of the directors and co-directors of the Center for Effective Teaching and Learning (Fetal) are funded by the provost/academic vice president, and can request and receive support from the institution's curriculum development fund for fetal programs. Two chemistry and one hydrology laboratories have been redesigned and institutionalized. The Department of Geological Sciences received NSF funding for the Building Pathways into the Geosciences for a Hispanic Community of Learners in El Paso Program.

Leveraged Funding

- NSF/CISE (Computer Science) connection between MIE supported STEM Entering Students Program and major in CS and evaluation support (received).
- NASA/Recruitment (Physical Sciences) evaluation support (received).
- NASA National Technical Information Service Grant evaluation support (received).

(*MIE Fact Book,* II-82)

Xavier University of Louisiana

Major Academic Events and Major MIE Activities

With the help of MIE funds and other leveraged funds—such as funds from Lily endowment/ UNCF-HBCU program and the Kresge Foundation developed a 100,000-square-foot science addition which doubled the teaching and research facilities available to STEM faculty and students. This was followed with widespread change throughout from its Internet and telecommunication infrastructure to its administrative infrastructure to ensure institutionalization of these changes. Changes included:

- The implementation of a new Data Management System (Banner 2000), which provides the University community with its first integrated management system with capacity to support student online registration, enhanced student advising, and student tracking;
- The establishment of the position of associate vice president for technology administration to ensure the coordinated management of planning and implementation of technology on the campus;
- Initiation of fundraising efforts for the purpose of supporting establishment of a bachelor of science degree program in computer engineering;
- Development of the Xavier University Center for Undergraduate Research to coordinate research activity between faculty and students;
- Establishment of a system that provides the equivalent of 12 credit hours of release time for faculty to pursue their research interests;
- Enhancement of the instrumentation and equipment infrastructure in science, engineering, and math department laboratories; and
- Appointment by the president, of a University Research Coordinating Team consisting of selected senior faculty, and chaired by the director of the office of sponsored programs. In an effort to tell our story, our outreach endeavors include the MIE newsletter and Web site located at http://www.xula.edu/Sponsored_Programs/xumie/sempage.html.

(*MIE Fact Book,* II-100)

Oyate Consortium

Oglala Lakota College

Policy Changes

There continue to be refinements of the distance learning policies regarding video conferencing and Internet instruction.

Institutional Revenues and Expenditure

The college received NSF funds to improve the equipment infrastructure in the environmental sciences by building three analytical testing facilities. The grant is for $500,000 per year for up to five years based upon progress. The other grant is for $200,000 for one year from the U.S. Department of Defense. The grant will be used to equip an information technology lab for the new information technology degree program. The new labs will include an analytical lab, Geographic Information Systems lab, and a biological sciences lab.

Institutionalized MIE Program Components

The grants from NSF and Department of Defense are being used to create enterprise opportunities in environmental analytical laboratories and information technology services.

The MIE program has led to the creation and staffing of the STEM departments. The program has increased the number of new positions that support STEM degrees to 12 full-time persons for teaching the new STEM degree programs.

Leveraged Funding

In-kind contributions have been provided in several key areas: student tuition support, faculty release time, facilities, laboratories, equipment, and staff/human resource support.

Major Departmental Changes

In academic year 2001–02, Oglala created and staffed the Science, Engineering and Mathematics Department. The program has increased the number of new positions that support STEM degrees to 12 full-time persons for teaching the new STEM degree programs.

(*MIE Fact Book,* II-117)

Sisseton-Wahpeton College

- The associate of science in computer systems technology degree was approved in April 2000.
- Continued opportunities for student research.
- The Smart Classroom will be built using Vocational Education funding awarded.

(*MIE Fact Book,* II-135)

Sitting Bull College

Institutionalized MIE Program Components

The two-year associate of science degree program in environmental science will be institutionalized upon completion of the MIE award.

(*MIE Fact Book,* II-152)

Final Reflections

Following are final thoughts from NSF staff members who helped to conceive the original MIE model and institutional implementation.

Susan Kenmitzer is currently NSF's deputy division director, directorate for engineering. During the early years of MIE, she served as a MIE project officer for UTEP.

Kenmitzer was convinced that all of the MIE components had to be implemented at once in order to "get the kind of movement that UTEP achieved." She found that other key elements to MIE success included sound management. For example, sound management meant insisting on a strategic plan that would be implemented within 90 days of the receipt of the reward. It also meant engaging a strong advisory board. As the program manager she also promoted project management plans and tight financial controls.

Connie Della-Piana is now a program evaluation manager in NSF's Office of Integrative Activities. During the early years of MIE, she was a faculty member for UTEP's Communication Department who moved on to become the lead program evaluator and, later NSF's director of evaluation.

Della-Piana provided insight about the faculty role in MIE success. She insisted that faculty could not achieve results alone, but needed support from their department chairs and peers and the institution's president and deans. To emphasize her point to colleagues about the need for collaboration, Della-Piana always reiterates the importance of not only seeing individuals, but rather a "community" in need. Still, she sees activities in which faculty should engage. Faculty should collect data that shows intermediate outcomes like course completion. More specifically, collected data should look at student performance within STEM courses. It is important to remember they should also measure persistence and retention. If necessary, STEM faculty should work with someone in the social sciences to construct the tools to measure all the relevant outcomes. Data collection should be driven by what needs to be known (questions and purposes) and documented as well as knowledge about the audience for the information.

As for faculty training, which was another substantial MIE program component, Della-Piana suggested that faculty be trained together along with their administrators. She saw faculty take great risks to implement the ideas that comprised the MIE training, but yet insisted that it was the "whole thing." This includes underlying infrastructure and faculty efforts that made the success possible.

John Cherniavsky is currently the senior executive human resources advisor for research at NSF. During the early years of MIE, he was part of the original team that developed the criteria for the MIE grant, served as the program officer overseeing Oglala Lakota College, and acted as the general MIE program officer.

Looking back on the success of MIE, Cherniavsky found that the key is having sustained and substantial financial investment. He said that financial investments in small institutions with strong management skills can lead to tremendous success in STEM. One of the principal places where the investment should be directed is into student scholarships. Another major target for investment should be the institution's information technology network. Lastly, Cherniavsky believes a key strategy for subsequent institutions should be the creation or enhancement of relationships with local universities to further the STEM education.

Lloyd Douglas is currently a program director for NSF's mathematical sciences programs. During the early years of MIE, he was a program officer for Xavier University and Universidad Metropolitana.

Similar to his colleague John Cherniavsky, Douglas also found scholarships to be a key component for MIE success. However, he also highlighted the role of a Saturday Academy for high school students opened by Universidad Metropolitana. By engaging students early, he believes Universidad Metropolitana set incoming students on a path toward success. According to Douglas, another means for setting students on the right path was the involvement of students in research. While undergraduate involvement in STEM research is uncommon generally, it was a key feature of MIE institutions. Lastly, he believes that institutions who don't receive the same level of financial investment as the other MIE institutions can still implement aspects of the model. In particular, he believes that any institution can decide to involve more undergraduates in STEM research. He also believes that institutions committed to STEM development should "reconsider their institutional budgets."

The following milestones represent a broad overview of the MIE program lifecycle;

2. Brief Chronology of MIE Milestones

Phase	Date	Milestone
Phase I: Development	January 1993	MIE model development period begins
Phase I: Development	March 1993	National Science Board approved the MIE program concept
Phase I: Development	November 1994	Site visits to implementation grant candidates begins
Phase I: Development	November 1994	Planning grant deadline
Phase I: Development	February 1995	Site visits to implementation grant candidates end
Phase I: Development	April 1995	Blue Ribbon Panel meeting convened to select final MIE awards
Phase I: Development	July 1995	Implementation awards made
Phase I: Development	December 1997	MIE model development period ends
Phase II: Implementation	January 1998	Implementation period begins
Phase II: Implementation	January 1998	Each MIE institution submitted a proposal requesting second-phase funding for an additional three years
Phase II: Implementation	June 2000	Some of the first students begin to benefit as MIE graduates
Phase III: Dissemination	January 2001	Institutionalization and dissemination period began
Phase III: Dissemination	July 2003	Systemic Research, Inc. publishes a fact book chronicaling a statistical history of MIE
Phase III: Dissemination	March 2005	AIR publishes an impact study
Phase III: Dissemination	June 2005	IHEP holds its dissemination conference
Phase III: Dissemination	July 2005	Systemic Research, Inc. publishes a MIE pamphlet identifying its program elements
Phase III: Dissemination	December 2005	Systemic Research, Inc. publishes a second MIE fact book
Phase III: Dissemination	July 2006	A new Web site is launched, called the Science Diversity Center, to link together MSIs and new STEM efforts
Phase III: Dissemination	August 2006	Formal MIE funding ends

The AIR Report

In its report, AIR *Creating and Maintaining Excellence: The Model Institutions for Excellence Program*, provides the following additional commentary on institutionalization efforts.

Institutionalization of the Projects:

A critical underlying assumption of the MIE program is that it would provide substantial resources to build or enhance undergraduate STEM projects that would lead to successful outcomes for students of color. The projects themselves would be responsible for ensuring that successful components would continue beyond NSF and NASA funding.

To varying degrees, each of the projects appear to be taking steps to institutionalize at least some of the efforts that MIE funds supported. Generally, the projects have made proactive commitments to support students through scholarships, grants, aid, stipends, and work-study; continue orientation programs and student support centers that enhance students' potential for STEM success; and support undergraduate research opportunities that anchor the students' motivation and persistence in STEM. Curricula and pedagogy have been revamped and faculty members now serve as mentors, tutors, and collaborators in student-led research projects.

Some of the program elements implemented as part of MIE have already been institutionalized (see table below; note that many program elements listed include only those for which explicit maintenance mechanisms have already been put in place). It is believed that many more steps towards institutionalization will be made as the MIE funding cycle nears its end.

MIE Institutionalization Efforts

Component	Element	UMET	XU	UTEP	OC	SC	BSU
Recruitment and Transition	High-School Outreach	X					
	Summer Bridge Program	X		X			X
	Tutoring	X		X			X
	Mentoring	X		X			X
	Scholarships/Stipends	X			X		
Undergraduate Research	Summer research internships	X					X
	Academic year research internships	X	X	X			
Curriculum Development	New curriculum	X	X	X	X	X	X
Physical Infrastructure	Space/equipment for students	X	X	X	X	X	X
	Equipment upgrades		X		X	X	

Source: AIR 2005.

Note: (In the table, UMET stands for Universidad Metropolitana, XU for Xavier University, UTEP for University of Texas at El Paso, OC for Oyate Consortium, SC for Spelman College, and BSU for Bowie State University.)

Additional Information on the MIE Dissemination Conference

The Institute for Higher Education Policy's National Dissemination Conference (June 23–24, 2005)

On June 23–24, 2005, the IHEP in collaboration with NSF, NASA, and the three organizations that compose the Alliance for Equity in Higher Education—the American Higher Education Consortium, Hispanic Association for Colleges and Universities, and National Association for Equal Opportunity in Higher Education—hosted a national conference to share how the MIE model can improve the capacity for STEM programs at MSIs.

The invited institutions were asked the following questions. These questions were intended to ascertain their views about the potential applicability of the model to their own contexts:

1. What are the key elements needed to implement STEM programs at your institution?
2. What are the key elements needed to sustain STEM programs at your institution?
3. What are the key elements to successful student participation in STEM programs?
4. What are the key elements to building and maintaining STEM infrastructure?

Following are their responses:

What are the key elements needed to implement STEM programs at your institution?
The principal answer was the need for a master plan. While financial support was also noted, participants suggested that the more important need was for institutions to coordinate their resources through one centralized location. It was noted that many of the components found in the MIE model were present on their campuses, but there was little communication or coordination among the different efforts. It was further stated that with a master plan, institutions would be more likely to define the roles of the people involved in STEM development, such as the president, provost, deans, faculty, and students. Moreover, someone would be identified as the person in charge of executing the plan. However, in order to craft a master plan the institutions suggested that faculty be given release time.

What are the key elements needed to sustain STEM programs at your institution?
Participating institutions said that sustaining STEM programs hinge on whether institutions commit themselves to the academic success of each student by bolstering his or her experiences outside the classroom.

Two of the other elements suggested by attendees validated those employed by the MIE program: student support (including that which could be obtained through the use of outside partnerships) and financial resources.

Institutions in Attendance:

Alabama State University

Albany State University

Bay Mills Community College

California State University, Fullerton

California State University, Sacramento

Chicago State University

Del Mar College

Denmark Technical College

El Paso Community College

H. Councill Trenholm State Technical College

Haskell Indian Nations University

Hostos College

Keweenaw Bay Ojibwa Community College

Lehman College

Little Priest Tribal College

Maricopa Community College

Medgar Evers College, The City University of New York

Northwest Indian College

Paine College

Prairie View A&M University

Saginaw Chippewa Tribal College

Southwestern Indian Polytechnic Institute

Turtle Mountain Community College

University of California, Irvine

University of Houston–Downtown

Victoria College

Winston-Salem State University

In addition to asking about sustainability, this group was asked what they would need to make the MIE/STEM model successful on their campuses. As in the previous question, most of their answers validated the MIE model while adding a few new ideas. For instance, the following list of needs mirrored existing MIE components:

- Infrastructure to provide continual support for STEM development;
- Support from institution leadership;
- Teamwork (collaboration, cooperation, and compromise);
- Curriculum development;
- Community/corporate and business partnerships;
- Internal dissemination of program successes and opportunities;
- Inspiration to continue on going progress;
- Passion to remain committed;
- Development workshops;
- Ability to build on success; and
- "Quality-time" for faculty to conduct research.

What are the key elements to successful student participation in STEM programs?

To answer this broader question, members of a breakout group stated what applications they saw in the earlier presentation offered by the MIE PIs to address student participation. They responded by listing the following elements as key:

- Keep students on campus for sufficient time to give them the support they need;
- Have the infrastructure of student services and administrative help;
- Have the ability to communicate effectively with a diverse student body;
- Find retention strategies that are specific to the sciences;
- Provide strong tutoring services;
- Provide study skill-related seminars;
- Provide work-study opportunities in the form of assistantships; and
- Facilitate the student loan process.

What are the key elements to building and maintaining STEM infrastructure?

While at first blush this question seems similar to the first that asks about "STEM implementation," this last question is asking about infrastructure (buildings, finances, lab equipment, etc.) more specifically. The first question asks more generally about STEM programs (tutoring services, assistantships, etc.).

Participants focused a lot of their attention on faculty. Similar to the other groups, they mentioned the need to obtain faculty and administrative "buy in." But they also said that initiating effective change among faculty cannot take place unless the institution can accomplish the following: (1) adjust for the influence of faculty unions, (2) be flexible enough to adjust with ever-changing leadership, and (3) provide meaningful reward systems.

Other elements they identified include the following:

- Construct a strategic plan that looks forward ten years.
- Spark the enthusiasm of the provost and president.
- Increase public relations efforts.
- Group STEM students into small clusters or cohorts.