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THE IMPACT OF CULTURE AND CONTEXT ON PROGRAM EVALUATION:

THE MODEL INSTITUTIONS FOR EXCELLENCE PROGRAM

AERA SIG-RESEARCH ON EVALUATION

EDUCATION PROGRAM EVALUATION AND EVALUATOR TRAINING FROM DIFFERENT CULTURAL PERSPECTIVES

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Executive Summary of the Report - Creating and Maintaining Excellence: The Model Institutions for Excellence Program

The Model Institutions for Excellence (MIE) program, initiated in 1994, is a joint venture between the National Science Foundation (NSF) and the National Aeronautics and Space Administration (NASA). The program was designed to increase the number of underrepresented minorities in science, technology, engineering and mathematics (STEM) through funding to a select group of minority-serving institutions (MSIs).

The MIE program aims to increase the representation of minorities in STEM by:

- Targeting a small number of MSIs poised to make a substantial contribution to increasing the number of minorities who earn STEM baccalaureate degrees and then enroll in STEM graduate programs or enter STEM careers;
- Improving STEM education and undergraduate research at the selected MSIs; and
- Enabling successful projects to serve as models for the recruitment, education and production of quality-trained STEM baccalaureate degree recipients.

In 1994, 69 MSIs were invited to submit MIE planning proposals. Fifty-seven MSIs submitted proposals and 20 were funded to develop implementation proposals. Six projects (one of which is a consortium of three colleges) received long-term funding for infrastructure development in STEM education and individual support to recruit and retain minority STEM students. The six MIE projects include: 1) Universidad Metropolitana in Puerto Rico; 2) Xavier University of Louisiana; 3) University of Texas at El Paso; 4) the Oyate Consortium (composed of Oglala Lakota College, Sitting Bull College and Sisseton-Wahpeton College located in South and North Dakota); 5) Spelman College in Georgia; and 6) Bowie State University in Maryland.

Xavier University, Universidad Metropolitana, University of Texas at El Paso and the Oyate Consortium are funded by the National Science Foundation. Spelman College and Bowie State University are funded by NASA.

About the Study

In 2004, NSF contracted with the American Institutes for Research (AIR) to conduct a short-term study to assess program impact and collect evidence of project success in infrastructure enhancement (i.e., courses, equipment, faculty), and student recruitment, retention, graduation and advancement in STEM careers. In addition, the study was to describe the project model(s) and determine whether or not the model(s) could guide national efforts for achieving and sustaining diversity in the STEM workforce.

AIR undertook a three-part study that involved secondary analysis of MIE and national data, case studies of the MIE projects to identify the project model(s) and benchmarking the core components of the model(s) against national standards.

Highlights from the Study

With one exception, from 1997-98 to 2003-04, STEM enrollment tended to increase faster than overall institutional enrollment at each MIE institution. (At Universidad Metropolitana, the enrollment more than doubled during the period, from 3,294 to 7,499 students (a 128-percentage point increase) and although STEM enrollment also more than doubled, it did not quite keep pace with the total.)

With one exception, from 1997-98 to 2002-03, the number of undergraduate STEM degrees conferred and the proportion of all degrees awarded that were in STEM fields increased considerably in all MIE institutions.

STEM degrees awarded tended to increase faster in the MIEs than they did overall in the Historically Black Colleges and Universities (HBCUs), Hispanic-serving Institutions (HSIs), and in the group of non-funded MIE applicants.

There appears to be one MIE model with seven essential components: recruitment and transition initiatives, student support, undergraduate research, faculty development, curriculum development, physical infrastructure development, and STEM graduate school and employment initiatives. Although each project looked somewhat different, student support (including social, financial, and academic assistance) received significant emphasis across all projects. Infrastructure enhancements included improvement or development of classrooms, laboratories, and specific areas in which students could study and work; purchases of state-of-the-art computing and laboratory equipment; hiring of over 100 new STEM faculty; curriculum enhancements at every project; and new STEM degree programs established at many. Undergraduate research opportunities were available both on- and off-campus, anchoring the students' motivation and persistence in STEM.

The study suggests that the MIE model is readily transportable, but that it must be aligned to the context and culture of the institution.

This paper specifically highlights the role of culture and context in the evaluation of this NSF/NASA sponsored program.

INTRODUCTION

The Model Institutions for Excellence (MIE) program, initiated in 1994, is a joint venture between the National Science Foundation (NSF) and the National Aeronautics and Space Administration (NASA). The program was designed to increase the number of underrepresented minorities in science, technology, engineering and mathematics (STEM) through funding to a select group of minority-serving institutions (MSIs).

Serious efforts to advance the position of minorities in science and technology originated in the early 1970s, motivated, in part, by Brown vs. Board of Education.[1] Yet despite decades of effort to increase diversity, about three-quarters of America's scientists, engineers, mathematicians and technologists today are male and four-fifths are white.[2] With an express mandate from Congress to promote diversity, the National Science Foundation reiterated its understanding of the challenge in its most recent Science and Engineering Indicators report as follows:

> Like the other industrialized nations, the United States faces a period of growing retirements among its S&E workforce. Unlike them, it has a growing population whose average age is projected to decline rather than increase. Its college-age population will increasingly be made up of minority group members, such as Hispanics, blacks, and American Indian/Alaskan Natives, whose current participation rates in S&E are half or less [than] those of white non-Hispanic students. As lower proportions of white non-Hispanic men obtain S&E degrees, the importance of women and minorities pursuing degrees in these fields rises.[3]

The MIE aims to increase the representation of minorities in STEM by:

- Targeting a small number of MSIs poised to make a substantial contribution to increasing the number of minorities who earn STEM baccalaureate degrees and then enroll in STEM graduate programs or enter STEM careers;
- Improving STEM education and undergraduate research at the selected MSIs; and
- Enabling successful projects to serve as models for the recruitment, education and production of quality-trained STEM baccalaureate degree recipients.

[1] National Science Foundation, 1993. Proceedings of the National Conference on Diversity in the Scientific and Technological Workforce: September 25-26, 1992 (NSF 93-22). Arlington, VA: National Science Foundation.
[2] BEST (April 2004). The Talent Imperative: Diversifying America's Science and Engineering Workforce. San Diego, CA: Building Engineering & Science Talent (BEST).
[3] National Science Foundation, Division of Science Resources Statistics. (May 2004). Science & Engineering Indicators 2004 (NSF 04-01). Arlington, VA: National Science Foundation.

In 1994, 69 MSIs were invited to submit MIE planning proposals. Fifty-seven MSIs submitted proposals and 20 were funded to develop implementation proposals. Six of the 20 received long-term funding for infrastructure development in STEM education and support to recruit and retain minority STEM students. The six MIE projects include eight colleges as follows:

- University of Texas at El Paso (UTEP);
- Spelman College in Georgia;
- Xavier University of Louisiana;
- Bowie State University (BSU) in Maryland;
- Universidad Metropolitana (UMET) in Puerto Rico; and
- Oglala Lakota College in South Dakota (the lead institution for the Oyate Consortium, which also includes Sitting Bull College and Sisseton-Wahpeton College).

Xavier University, Universidad Metropolitana, University of Texas at El Paso and the Oyate Consortium are funded by NSF. Bowie State University and Spelman College are funded by NASA.

The minority-serving institutions participating in the MIE program are remarkably different in terms of size, history and population served:

- Three of the MIEs are Historically Black Colleges and Universities (HBCUs) (Spelman, Xavier and Bowie). Two of the MIEs (Universidad Metropolitana and University of Texas at El Paso) are Hispanic-serving Institutions (HSIs). The three schools involved in the Oyate Consortium are tribally-controlled colleges (TCCs).
- Spelman, Xavier and Universidad Metropolitana are private. Bowie, the Oyate Consortium schools and UTEP are public.
- Two MIEs (Spelman and Xavier) had long-standing, recognized STEM programs at the time they were funded.
- Two MIEs were founded in the 1800s (Spelman in 1881 and Bowie in 1865); two were founded in the first quarter of the 20th century (University of Texas at El Paso in 1916 and Xavier in 1925); and two were founded after 1970 (the Oyate Consortium colleges and Universidad Metropolitana).
- Xavier is a Roman Catholic school; the others are non-sectarian.
- Tuition ranges from under $5,000 at the University of Texas at El Paso to over $15,000 annually at Spelman College.
- Two have selective admission policies (Spelman and Xavier), two have somewhat selective admission policies (Bowie and University of Texas at El Paso) while the others (Universidad Metropolitana and the Oyate Consortium) are open-admission schools.
- Spelman is an all-women's college; the others are coeducational.

In addition, one of the projects funded was a consortium of three tribally controlled colleges.

In 2004, NSF contracted with the American Institutes for Research (AIR) to design and implement a short-term study to assess program impact within MIE institutions, across MIE institutions, and against a national framework for achieving diversity. The following research questions guided this effort:

- What evidence is there of project success in meeting program goals with respect to student recruitment, retention, graduation and advancement in STEM careers?
- What evidence is there of project success in meeting program goals of strengthening institutional infrastructure (i.e., courses, equipment, faculty, etc.)?
- What project models have been created? What are the major elements in each project? Are there distinct models, core variables?
- Are the project models transportable, credible (i.e., do they align with current research models for encouraging diversity within a university)? Can project models be identified to guide national efforts for achieving and sustaining diversity in the STEM workforce?

To answer these questions, AIR undertook a three-part study that involved secondary data analysis, case studies, and benchmarking. Specific activities included:

- Reviewing extant data on the MIE projects that measure the number and characteristics of STEM students and faculty and the ability of the MIEs to serve students' needs;
- Reviewing national data to place MIE findings in a larger context;
- Reviewing all of the available proposals and reports submitted by the MIE projects in an effort to clarify the goals and activities of each project over time;
- Visiting each project to meet with key individuals (including administrators, project directors, faculty, students, and graduates) and to document some of the advancements put in place with MIE funds;
- Comparing projects and outcomes to determine the model(s); and
- Benchmarking the core components of the model(s) against national criteria.

Following this Introduction, this paper report first lays out our conceptual model in Section 2. Section 3 describes the MIE colleges and universities and the projects as implemented at the institutions; this section is highly detailed and descriptive which is required to understand the cultural context of the institution. Section 4 presents the conclusions to the study and describes the role of context and culture in the MIE institutions.

SECTION 2. THE MIE MODEL

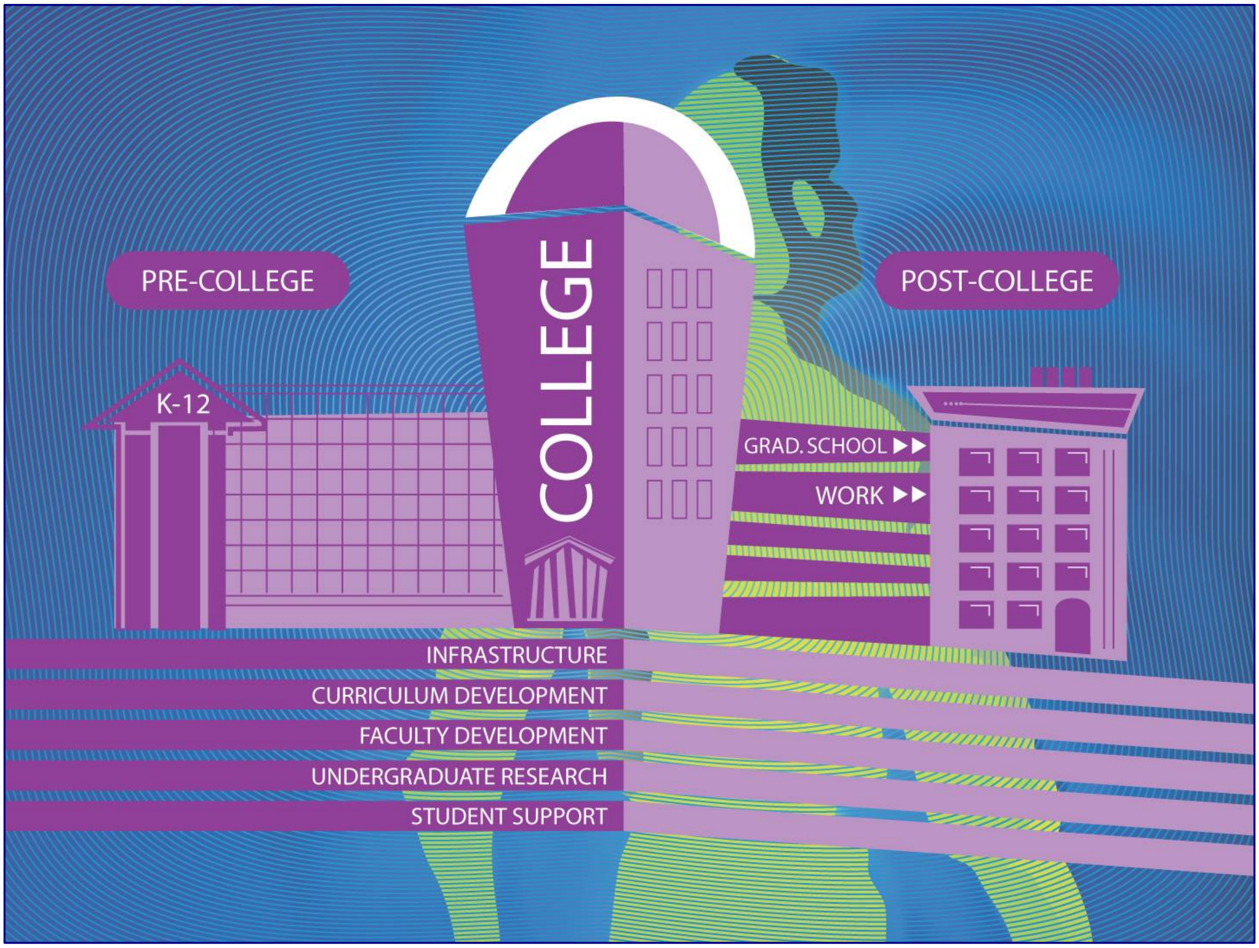
Our review of the MIE projects suggested a model with seven components. These components are defined as follows:

- **Recruitment and Transition Initiatives**: Activities to prepare matriculating students to succeed in college and to introduce students to STEM disciplines and careers. These initiatives include such activities as:
    - 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, Geographic Information Systems (GIS) mapping)
    - Bridging the transition from high school or community college into college or university (e.g., summer orientation programs)
- **Student Support**: Social, financial, and academic assistance to students. This includes such activities as:
    - Supporting peer and/or teacher/student mentoring programs
    - Tutoring
    - Providing and/or 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
    - Especially at commuter campuses, establishing a place where groups of students can meet and study with one another
    - Scholarships, grants and funding for research and presentations of research projects
- **Undergraduate Research**: Enabling students to become directly involved in on-going research. Associated activities might include:
    - Encouraging faculty to include funding for undergraduate researchers in their research proposals
    - 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
    - Maintaining a supportive environment in which a student may experiment (and fail) without negative consequences

- **Faculty Development**: Recruitment, retention and professional development of faculty. This includes:
    - Funding for research, conferences, and professional development
    - Mentoring
    - Setting appropriately balanced (and rewarded) teaching and research agendas
    - Professional development on interactive classroom methods, mentoring, and integrating student researchers into faculty research activities
- **Curriculum Development**: Alignment of curriculum with accepted content standards and the development of courses that are relevant to the marketplace, the community and the student population. These activities include:
    - Providing developmental courses to bring 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
    - Developing new courses and majors
- **Physical Infrastructure**: Upgrading and maintaining facilities and equipment. This includes:
    - Renovating classrooms and laboratories
    - Purchasing, upgrading and maintaining state-of-the-art equipment
    - Designing spaces for students to meet and study
- **Graduate and Science Career Initiatives**: Activities designed to facilitate admission and retention in STEM graduate programs and/or careers. Related activities include:
    - Providing graduate school admissions test preparation courses
    - Educating students on academic and professional supply and demand trends in STEM fields
    - Establishing a bridging program for students transitioning out of college
    - Providing job placement services

Figure 1 is a graphic representation of the seven-component model. Note that pre-college activities (i.e., recruitment and transition initiatives) and post-college activities (i.e., graduate and science career initiatives) appear independent of the five in-college components, but that all seven are integral to the MIE model.

Figure 1. The MIE Model



Conceptually, we assumed that the weight of each component in any particular MIE project would depend on the institution's situation at the start of the project and what it deemed necessary to improve its STEM undergraduate program. At a selective school like Spelman, for example, recruitment and transition initiatives might not be expected to play a significant role in the design of their MIE project for several reasons:

- Recruitment is not an issue; with a 39 percent acceptance rate in 2004,[4] Spelman has many more applicants than it can accept.
- Spelman had a shift in admission priorities that limited the number of STEM admissions relative to general admissions.

[4] http://www.hbcumentor.org/campustour/undergraduate/539/Spelman_College/Spelman_College3.html

- Developmental science and math courses are not likely to be widely necessary, because most Spelman students can be expected to have adequate science and math backgrounds.
- Spelman has a national reputation with 83 percent of its students coming from out-of-state; it would be difficult for the college to influence or even interact with the many high school districts from which its students graduate.

In contrast, the University of Texas at El Paso (UTEP) has a less selective admissions process and about seven times as many undergraduates as Spelman (14,957 vs. 2,142 in 2002). Most UTEP students come from the El Paso area and a significant number come from Ciudad Juárez, El Paso's sister city across the border. Most matriculating students are not well-prepared in science and math and many are the first in their families to go to college. In this environment, UTEP has an opportunity to work with the local school districts to promote math and science and must support not only developmental science and math courses but orientations that introduce new students to the college amenities and prepare them for college life.

> *The context and history of each institution adds complexity to the design and implementation of the projects. Any evaluation needs to account for that complexity in its design and implementation.*

Adding complexity is the context and history of the institution. For schools such as the three TCCs that form the Oyate Consortium, open admissions from local area schools—most of which are on the reservations—has fostered a longstanding and close bond between the districts and the schools. Many K-12 initiatives had begun before MIE and will continue after MIE funding ends. Thus, although some recruitment and transition initiatives can be linked directly to the MIE project (e.g., hands-on 6th-grade visits to the GIS lab at Oglala Lakota College), the MIE project there did not have a strong recruitment and transition focus.

Finally, MIE was generally not the only grant-funding entity providing STEM resources to these schools. Funding from other sources came from individuals, private foundations, and state and federal sources, including NSF and NASA. Because the MIE funds could not be used for construction, they were used instead to develop and institutionalize STEM programs and to leverage those funds with other foundations, businesses and federal agencies. Other activities *related* to MIE activities (most notably the building of new facilities) were financed by other sources.

It is important to keep in mind that our description of the projects is qualitative rather than quantitative and that we do not include here every element of every component. Emphasis on one component does not imply a specific level of quantification. Neither does it imply that other components were not addressed. In some cases (e.g., recruitment at Spelman), no MIE project effort was required because that component was well established prior to the start of MIE.

SECTION 3. THE MIE PROJECTS

To understand the six MIE projects, it is necessary to know something about the history and culture of each institution prior to funding. While each of the projects aimed to increase the representation of minority students in STEM fields, each did so in different ways. This section briefly describes each institution and then discusses the MIE project implemented at each.

Universidad Metropolitana (UMET)

Universidad Metropolitana, established in 1980, is a private university in San Juan, Puerto Rico. One of four institutions in the Ana G. Mendez University System, the university serves Puerto Rican students almost exclusively, and female students outnumber males by more than two to one. UMET is primarily a commuter school. The vast majority of UMET students come from low-income families, are first-generation college students, and 92 percent receive some form of financial aid. Many had never considered a college education, much less careers as scientists and engineers.

At the start of the project, UMET had only four STEM degree programs.[5] The limited number of STEM faculty was expected to teach 15 hours and had little interest in research. (In 1995, not one STEM faculty member had received competitive research funding.) Laboratories and scientific equipment were minimal, and the curriculum was quite basic.

The MIE project at Universidad Metropolitana puts its emphasis on

UMET's eight-week summer internship offers undergraduates the opportunity to work with world-class scholars at major research institutions on the U.S. mainland and around the world.

[5] The 1994 MIE proposal lists Biology, General Science,

curriculum development and undergraduate research. The primary initiative in this area is an eight-week summer internship during which undergraduates work with world-class scholars at major research institutions on the U.S. mainland and around the world. MIE pays for their travel and pays them a stipend during their stay. Undergraduate research in the summer of 2003 included opportunities in China, Japan, Spain, the Netherlands, Germany, Canada, South Africa and the United States. Some aspects of student support can also be said to contribute to the undergraduate research opportunities. These include one-to-one advising and mentoring from both faculty and peers focused on enhancing both academic and research skills. Table 3 highlights the elements of the MIE project at Universidad Metropolitana.

Table 3. Elements of MIE Components at Universidad Metropolitana

Components	Elements
Recruitment and Transition Initiatives	• Summer Adventure Research Training (SART) trains students from the 10th, 11th and 12th grade in short-duration research projects • Saturday Academy promotes the active participation of 10th, 11th, and 12th-grade students in science projects during weekly Saturday meetings • Summer Bridge Program allows students to take first-year courses in mathematics, computer science, and English language during the summer prior to entering UMET • Pre-college Research Symposia student participants in the Saturday Academies have the opportunity to practice their communication skills by presenting the results of their research to the university community
Student Support Initiatives	• Science Support Center provides: o Orientation program for entering freshmen o Spanish and English Language Program o Academic advising, counseling, placement, tutoring and mentoring o Programs in critical thinking, problem-solving, study habits, and academic planning • MIE scholarships offer economic support to students who demonstrated high potential for completing their bachelor's and continuing to graduate studies • Both faculty and peer mentors offer one-on-one advising and tutoring to STEM students focused on enhancing academic and research skills
Undergraduate Research Initiatives	• Summer Undergraduate Research Internships offer students travel to research institutions worldwide (e.g., Johns Hopkins, Carnegie Mellon, UCLA) for an 8-week hands-on research experience • Undergraduate Research Symposia focus on student-selected topics or topics developed collaboratively with faculty • Summer undergraduate research exchange program with other MIE institutions enables students to participate in the work of other MIE projects • MIE sponsors students to make conference presentations
Faculty Development Initiatives	• Workshops for faculty on how to write research proposals • Reduced teaching loads and financial incentives for faculty engaged in research
Curriculum Development Initiatives	• Advanced courses added to the curriculum • A more hands-on approach to teaching was advocated • Expanded from four to 13 STEM bachelor's degree programs

Table 3. Elements of MIE Components at Universidad Metropolitana (continued)

Components	Elements
Physical Infrastructure Initiatives	• Science Support Center provides space for students to study in groups • New laboratory facilities have been developed • New computer equipment has been purchased
Graduate and Science Career Initiatives	• The Bridge to Graduate Program provides access to information to facilitate graduate school admission and support to complete the application process

Xavier University of Louisiana

Xavier University of Louisiana is the only university in the United States that is both historically Black and Catholic. Founded as a secondary school in 1915, it evolved into a normal school for African American teachers in 1917, established a College of Liberal Arts and Sciences in 1925 and added a College of Pharmacy in 1928. In 2004, the student body numbered approximately 4,100, with 35 percent from Louisiana and the remainder from over 40 states and 20 foreign countries.

Since 1994, Xavier has ranked first in the nation in placing African American students into medical schools. More recently, Xavier has also ranked first in the nation in the awarding of Bachelor of Science degrees to African Americans in both life and physical sciences. Using MIE funds, Xavier sought to enhance an already strong and successful program by focusing on physical infrastructure, recruitment and transition initiatives, and retention.

Specifically, in 1994, many of the science faculty and most of the students did not have computers, and thus had limited means for electronic communication. MIE funds were used to purchase and network computers on campus. The second focus was to increase the number of students entering the University who would become STEM majors and to recruit those enrolled who were not already committed to pursue graduate study, with specific targets established for each academic major. Finally, MIE funds were used to increase the rate of retention, graduation and placement in graduate school or STEM employment from approximately 55 percent to 75 percent of students.

Not surprisingly, therefore, the primary emphasis of Xavier's MIE project also appears to be student support. In this case, Math, Science, Technology, Engineering and Research (MaSTER) scholars received up to full tuition support and were required to perform at least eight hours of research a week and hold at least one off-campus summer internship.

Aspects of some of the other components also seem student-centered. For example, one undergraduate research initiative hosts seminars and workshops in which invited guests and students present their work. There is also support for student and faculty mentor travel to conferences and symposia. One aspect of faculty development is the provision of mini-grants to faculty to help support research with students. As part of infrastructure development, Xavier has created resource and mentoring centers in which students have access to computers, technical support, and on-campus study areas.

Table 4 outlines particular aspects of the MIE project at Xavier.

Table 4. Elements of MIE Components at Xavier University of Louisiana

Components	Elements
Recruitment and Transition Initiatives	(Recruitment was already beyond capacity; no supplemental recruitment initiatives were required.)
Student Support Initiatives	• Math, Science, Technology, Engineering and Research (MaSTER) scholars, selected from among incoming freshmen, receive full tuition for the academic year and are required to perform at least 8 hours of research a week, participate in GradStar (see below), write progress reports, present on their research, and hold at least one off-campus summer internship • Faculty mentors • Developmental courses in writing, mathematics and English
Undergraduate Research Initiatives	• Center for Undergraduate Research (CUR) hosts seminars and workshops in which invited guests and students present their work and supports student travel to conferences and symposia • Publication of an internet journal for Xavier University students • The campus-wide Festival of Scholars, highlighting research and creativity of Xavier students • Faculty mini-grants that fund research with students • Summer Research internships required for MaSTER scholars
Faculty Development Initiatives	• Research work with undergraduates considered in tenure decisions • Reduced teaching load for new STEM faculty • Mini-grants support start-up faculty research projects
Curriculum Development Initiatives	• New or updated STEM curriculum • New degree program in Computer Engineering • Proposed program in Electrical Engineering

Table 4. Elements of MIE Components at Xavier University of Louisiana (continued)

Components	Elements
Physical Infrastructure Initiatives	• New Science Annex contains 24 teaching labs, 9 research labs and state-of-the-art electronic/multi-media classrooms[6] • Video conferencing capabilities have been expanded • Increased computer networking capacity • Computer resource laboratories • Resource and Mentoring Centers provide students with access to over 125 computers, technical support and on-campus study areas
Graduate and Science Career Initiatives	• GradStar is a campus-wide program that offers GRE prep courses, semi-monthly seminars, and application completion assistance. Although *not* MIE funded, MaSTER Scholars are required to participate

University of Texas at El Paso (UTEP)

University of Texas at El Paso (UTEP) opened its doors to 27 students in 1914 as the Texas State School of Mines and Metallurgy to meet the demands of a growing technical market. Since that time, more than 76,200 students have earned degrees through the School of Mines and Metallurgy at UTEP. As a public doctoral granting institution, UTEP today serves almost 19,000 students. The College of Engineering and the College of Science account for 13 and 8 percent of the student body, respectively.

UTEP is located in west Texas along the Texas/Mexico border in one of the five poorest cities in the nation. Almost all of UTEP's students are commuters. Over 80 percent of UTEP's students have financial responsibilities and most are working to support themselves through college. Over 50 percent of its students receive need-based financial support. A majority of the student body are first-generation college students, many of whom are inadequately prepared for college. Thus, the MIE project was designed to help science and engineering students succeed academically, work together within and across disciplines, and participate in undergraduate research during the academic semester.

The majority (82.3 percent) of UTEP students come from El Paso County, and the remaining are mainly from other parts of west Texas, northern Mexico, and southern New Mexico. Seventy-one percent of UTEP students are U.S.-origin Hispanics and the remainder are international students, mainly Mexican, the majority of whom live in Ciudad Juárez, across the Rio Grande. UTEP is the largest Mexican-American university and the second largest Hispanic majority university in the nation.

[6] Although no MIE funds were expended for the construction of this building, some of the scientific equipment and computers with which the classrooms and laboratories were equipped were purchased with MIE funds.

Prior to MIE, the six-year university-wide graduation rate was no different than that of many other institutions with similar demographics. Based on data from the 1990s, the six-year graduation rate for the Colleges of Engineering and Science at UTEP was slightly lower than the university-wide rate, despite the fact that the first-year retention rate in these colleges (approximately 70 percent) was higher than that of the general university (approximately 66 percent). UTEP took a strategic approach, focusing on STEM student retention and success. The goal, then, was to increase the per-year STEM student retention rate by 10 percent, and to effectively double the number of STEM degree recipients.[7]

The UTEP MIE project focuses on student support, including freshman orientation, clustering, competitive stipends, mentoring, tutoring, peer facilitation and physical space in which to work on the busy commuter campus.

At the University of Texas at El Paso, four Academic Centers for Engineers and Scientists (ACES) provide study space for individuals and groups, contain computer labs, offer laptop computers that students can check out, and provide office equipment (e.g., FAX and photocopy machines) that STEM students may use. Tutoring and computer support are provided by STEM students who receive stipends for their work. ACES is a critical element of both student support (because of the services it provides) and physical infrastructure (because it enables students at this commuter college to have a place to meet and work on campus). Table 5 details the components of the MIE project at UTEP.

[7] Flores, B.C.; Della-Piana, C.K.; Brady, T.; Swift, A.; Knaust, H.; & and Jana Renner Martínez, J.R. *Proceedings of the 2002 American Society for Engineering Education Annual Conference & Exposition* Copyright © 2002, American Society for Engineering Education

Table 5. Elements of MIE Components at University of Texas at El Paso

Components	Elements
Recruitment and Transition Initiatives	• The local Women in Science and Engineering (WiSE) affiliate sponsors an Expanding Your Horizons™ conference for middle school girls interested in pursuing STEM careers • STEM faculty and students host workshops and give presentations at an annual Girl Power Conference organized by the El Paso Independent School System and affiliated with WiSE • Circles of Learning for Entering Students (CircLES) provides freshman orientation, advising and registration services, and academic clustering in gatekeeper freshman-level courses
Student Support Initiatives	• Four Academic Centers for Engineers and Scientists (ACES) provide tutoring and computer support from STEM students who receive stipends for their work, maintain test banks and study guides and are equipped with laptop computers that STEM students may check out and office equipment (e.g., FAX and photocopy machines, scanners, etc.) that students may use • Paid stipends offer opportunities in research, tutoring, and peer support
Undergraduate Research Initiatives	• Research Experience for Undergraduates (REU) provides stipends to qualified STEM undergraduates to conduct research during the academic year • Faculty include funding for undergraduate summer stipends in their grant proposals
Faculty Development Initiatives	• Center for Effective Teaching and Learning (CETaL) organizes workshops and seminars, develops teaching materials, provides research and publication support and maintains a library on effective teaching and evaluation • Faculty are rewarded for innovative and effective teaching
Curriculum Development Initiatives	• Course, Curriculum, and Laboratory Improvement (CCLI) developed modularized pre-calculus courses, developed an environmental science program, introduced peer leaders into the classrooms and developed learning communities
Physical Infrastructure Initiatives	• Academic Center for Engineers and Scientists (ACES) provides study space and computer labs for individuals and groups
Graduate and Science Career Initiatives	• Academic Center for Engineers and Scientists (ACES) maintains graduate school and employment information • Research Experience for Undergraduates (REU) prepares students for graduate school, and offers GRE prep courses and professional development workshops

The Oyate Consortium

The Oyate Consortium is a partnership among three tribal colleges in South and North Dakota (Oglala Lakota College, Sitting Bull College and Sisseton-Wahpeton College). The colleges serve Native American students from the Pine Ridge, Standing Rock and Lake Traverse (Sisseton) reservations as well as non-Native Americans from the area. At 1.7 million acres, Pine Ridge is the second largest Indian reservation in the country. Because of its large coverage area, OLC is a decentralized campus with 12 education centers. The consortium offers on-site and distance education, utilizing the Blackboard Learning System.

Together, the three schools have an enrollment of close to 2,000 students,[8] about half of whom attend full time. The large majority of Oyate students are female with children, with an average age of 29. Ninety-five percent of the students are on financial aid. Although a keen understanding of mathematics and science has always been a part of Lakota and Dakota teaching and learning, beginning with a profound respect for and spiritual connection with the land, most matriculating students score 30-40 percent below the state average on standardized tests in math and science. Thus the consortium needed to establish not only college-level but also developmental courses that would prepare incoming students for the more rigorous college-level courses.

All of the consortium colleges were founded in the 1970s. At the start of the MIE project in 1995, none of the partners had STEM degree programs or sufficient numbers of qualified staff to teach STEM courses at the college level. The straightforward goal of the MIE project was to "create an opportunity for science, engineering and mathematics education" which did not then exist.[9]

> *The MIE project has enabled TCCs to develop STEM programs that focus on reservation issues. This has had a positive systemic impact, giving the tribes an awareness of the value of STEM as a viable tool for planning and policy change.*

Because STEM education at the Oyate Consortium schools was so very limited at the start of the MIE project, the schools have had to divide their resources between more components, making the project look quite different from the others. Table 6 outlines the Oyate Consortium elements, noting the particular school at which that element was implemented when implementation was not universal.[10]

[8] Stacy Phelps, personal communication, 3/16/05.
[9] Oglala Lakota College Program Proposal (ID # HRD-9550533) to the National Science Foundation (p. 1)
[10] "OLC" is Oglala Lakota College; "SB" is Sitting Bull; and "SWC" is Sisseton-Wahpeton College.

Table 6. Elements of MIE Components at Oyate Consortium

Components	Elements
Recruitment and Transition Initiatives	• OLC: six-week summer program for 9th through 12th-grade students to preview math/science content the students will encounter during the next school year • OLC: reservation-wide science fairs and science clubs • OLC: hands-on student visits to geographical information systems (GIS) lab • OLC: two-week environmental education program for K-12 teachers • OLC: secondary education physical science degree to enhance the teaching of science in the high schools • High-school student summer research project • SBC: Sunday Academies bring high school students to campus to conduct research with college students • SBC: one faculty member allows high school students to help with field research in the summer, with college students serving as mentors • SBC: early entry/dual credit program • SWC: Science Fun Day for elementary students to do science experiments • SWC: students help at the local reservation schools and recruit science talent in the upper grades
Student Support Initiatives	• Assistance in obtaining merit-based scholarships • Grant-funded research projects and internships • Student stipends • Mentoring and tutoring • Memberships in professional organizations such as the American Indian Science and Engineering Society (AISES) (an AISES chapter has been founded at SWC) and the Society for the Advancement of Chicanos and Native Americans in Science (SACNAS) • Distance education • SBC: Challenge Education Weekend for freshmen • SWC: each new student is paired with an older student as a mentor • SWC: Learning Lab with computer-based tutorials for math
Undergrad-uate Research Initiatives	• Field work on the reservation • Participation in the American Indian Higher Education Consortium (AIHEC) competition • On- and off-campus poster presentations • SBC: two semester class in which students develop and research a topic of interest and present their findings to a panel of four faculty members • SWC: research projects focus on student (rather than faculty) interests and are Dakota-centered • OLC: Lakota Center for Science and Technology supports reservation-based undergraduate research

Table 6. Elements of MIE Components at Oyate Consortium (continued)

Components	Elements
Curriculum Development Initiatives	• OLC: created 80 new STEM courses • OLC: developed bachelor's degree programs in Information Technology and Interdisciplinary Environment Science • OLC: developed associate degree programs in Science, Engineering, Math and Life Sciences • SBC: developed 29 new math and science courses • SBC: developed associate degree programs in Environmental Science, Natural Resource Management, and Computer Technology (and a bachelor's degree program in Interdisciplinary Environmental Science through OLC) • SBC: Every course is required to have technology embedded in it and an introduction to computers course is required by every degree program • SWC: created associate's degree programs in Computer Systems Technology and Interdisciplinary Environmental Science • OLC: submitted for approval to the North Central Accrediting Association a master's degree in Natural Resources and Environmental Science; if approved, it will be the first master's degree offered by a TCC
Physical Infrastructure Initiatives	• New and renovated classrooms, including distance learning classrooms with smart boards, computerized podiums • Computer laboratories developed and science laboratories renovated • OLC: purchased and installed over 450 computers • OLC: video lab and high-definition camera • Memorandum of Understanding with South Dakota School of Mines to share equipment • OLC: revamped its distance learning system, replacing videoconferencing with one that allows on-demand access • SBC: purchased scientific equipment
Graduate and Science Career Initiatives	• Internships at South Dakota School of Mines, the University of South Dakota, and at OLC • OLC: developed small IT company to create jobs on reservation • OLC: established the first EPA-certified analytical testing lab, the first in a TCC in Region 8 • SWC: requires STEM students to complete an internship

Spelman College

Founded in 1881, Spelman College has established a national and international reputation as an elite institution among private liberal arts colleges. Spelman is one of only two Historically Black Colleges and Universities (HBCUs) exclusively for women.[11] With 26 majors, including coursework in pre-law and pre-medicine sequences, and as a member of the largest consortium of HBCUs known as the Atlanta University Center, the institution is nationally recognized for its academic programs as well as the leaders it graduates.

Prior to MIE funding, Spelman was recognized for its strong science programs. Indeed about a third of its students were enrolled in STEM fields at the start of MIE funding. In addition, Spelman had a long history of obtaining financial support from foundations, private donors, and government agencies. Spelman's application for MIE funding explicitly stated that they were not interested in improving their already impressive recruitment of students to STEM fields but rather in improving their STEM programs (including their laboratories and facilities) and retaining students once enrolled.

The primary strength of the MIE project at Spelman is its student support. A school with a very long history, significant financial resources, and high academic expectations, Spelman concentrated its MIE efforts on STEM students. Four-year MIE Research Scholars receive scholarship funds each year. They are required to take a number of extra courses and apply for summer research internships. Each scholar is assigned a research advisor, to act as a mentor and to guide the scholar in her academic pursuits. Both freshmen and sophomores who receive less than a passing grade on the first exam in any STEM course are invited to meet with a "success coordinator" to devise a plan to improve their grade in the course. In this way, the student can catch and correct the problem before the course has progressed too far. In addition, through individual and group tutorials, a summer science program for sophomores targets those who need extra assistance to improve their academic performance.

New Ph.D.s are brought to campus for one or two years with reduced teaching loads to conduct research with and mentor students.

This is not to say that Spelman's project does not include all of the anticipated components. It addresses each one, but to a lesser degree. In addition, the features of some of the other components also bolster student support. For example, in the area of faculty development, the Scholar Teacher Program brings new Ph.D.s to campus for one or two years with reduced teaching loads to conduct research and mentor students. In infrastructure development, Spelman reconfigured and renovated additional space for students to meet, study, and receive tutoring. Even aspects of Spelman's curriculum development seem particularly student-centered: as part of the MIE project, interactive and group learning are encouraged and there has been a shift in the focus of courses to

[11] The second is Bennett College in North Carolina.

analytical thinking and problem solving. This reinforces the mentoring and group processes that enable the students to help one another and build on their strengths.

Table 7 specifies the elements of each component that together describe the MIE project at Spelman.

Table 7. Elements of MIE Components at Spelman College

Components	Elements
Recruitment and Transition Initiatives	• Six-week Pre-Freshman Summer Science Program for freshmen who intend to pursue STEM majors • Organized visits to campus for local high school students
Student Support Initiatives	• In the Freshman Success Program, a Freshman Success Coordinator contacts all first- and second-year students who receive less than a passing grade on the first exam in any STEM course and invites them to a meeting to devise a plan to improve their grade in the course • Post-Freshman Summer Science Program is designed for sophomores who need extra assistance to improve their academic performance through individual and group tutorials • Office of Science, Engineering, and Technical Careers, while not funded by MIE, provides counseling and enrichment activities to help STEM majors find internships and sponsors students to enroll in an on-campus GRE prep course • Four-year MIE Research Scholars receive scholarship funds each year. They are required to take a number of extra courses. Each scholar is assigned a research advisor, to act as a mentor and to guide the scholar in her academic pursuits. Scholars are required to apply for summer research internships • Tutoring
Undergraduate Research Initiatives	• Project Focus Teams in which students work together under the guidance of a faculty Team Leader • In return for a one-time financial award, MIE Research Interns work with faculty, spending at least 10 hours per week for a semester doing research • Annual MIE SEM day, with panels and lectures by scientists and oral and poster presentations by students • Supported attendance at professional conferences
Faculty Development Initiatives	• Scholar Teacher Program brings new Ph.D.s to campus for 1 or 2 years with reduced teaching loads to conduct research with and mentor students • An Instructional Technology Specialist was hired to develop and distribute a multi-media manual to STEM faculty and staff, and to conduct workshops on the use of multi-media classrooms • Faculty are provided with support to attend professional meetings and workshops on new teaching strategies

Table 7. Elements of MIE Components at Spelman College (continued)

Components	Elements
Curriculum Development Initiatives	• Recitation added to Biology • Language changed from Pascal to C++ • Transition to multi-media instruction as computers were added to laboratories • New courses, including Electromagnetic Theory, Introduction to Research Methods, and Laser Optics • Interactive and group learning encouraged • Shift in focus of courses to analytical thinking and problem solving • Environment Sciences degree program
Physical Infrastructure Initiatives	• Space for students to meet, study, and get tutoring • New state-of-the-art science center (constructed with support from over 120 individuals and foundations)[12] • MIE-funded laboratory equipment and new computers
Graduate and Science Career Initiatives	• Office of Science, Engineering, and Technical Careers offers counseling and enrichment activities to STEM majors • Career workshops for MIE Research Scholars • Workshops on career opportunities

Bowie State University

Bowie State University, the oldest HBCU in Maryland, was founded in 1865 as the Baltimore Normal School. In 1935, it evolved into a four-year program and in 1988 became part of the University of Maryland system. Today, the university offers 19 undergraduate and 19 graduate degree programs and ranks first in the production of African Americans with master's degrees in computer science and information sciences.

Student enrollment numbers over 5,000 and includes primarily non-traditional commuter students from Prince George's County, Maryland. Between 1991 and 1994, before MIE funding, the number of students enrolled in STEM majors had essentially plateaued and the attrition rate was 20 percent per year.

Unlike the situation at Spelman and Xavier—both HBCUs with very selective admissions policies and extensive, well-established STEM departments—Bowie is a public university that accepts about half of its applicants. The non-traditional students who make up the majority of Bowie's population have not generally been encouraged to excel in STEM courses and careers. Local students who might be so inclined would be more likely to attend one of the two research universities in the

[12] Although no MIE funds were expended for the construction of this building, some of the scientific equipment and computers with which the classrooms and laboratories were equipped were purchased with MIE funds.

University of Maryland system.[13] Accordingly, Bowie focused its MIE project on the recruitment and retention of STEM students.

Bowie's STEM faculty more than doubled (from 23 to 57) between 1994-95 and 2001-2002.

Bowie's MIE recruitment and transition initiatives reach middle and high school students as well as middle and high school teachers. Student support initiatives include monetary assistance in the form of tuition assistance, stipends, and assistantships; developmental courses; tutoring and mentoring. Bowie also has "retention coordinators" who monitor all STEM students and refer those that need it to advisement services and, like Spelman, to a summer session explicitly for STEM sophomores who are falling behind their peers. Some initiatives that are included in other components also have a strong element of student support, although there are not as many "crossovers" in the Bowie project as there were at Spelman and Xavier. For example:

- Two initiatives categorized as physical infrastructure have a strong student support component: five computing labs opened with MIE-funded student tutors and lab monitors
- The STEM network connected over 500 computing devices, providing faculty, staff and students with access to high-end servers
- Two undergraduate research initiatives also provide both internship and employment opportunities.

Table 8 outlines the elements of each component of the MIE project at Bowie.

Table 8. Elements of MIE Components at Bowie State University

Components	Elements
Recruitment and Transition Initiatives	• BSU students work with high school and middle school teachers on using technology in the classroom • Undergraduate and graduate BSU students and middle and high school students present poster sessions on their research at the MIE Showcase

[13] These are the University of Maryland, Baltimore County and the University of Maryland, College Park (UMCP). The latter is the state's flagship institution, with 52 programs ranked in the top 25 nationally. UMCP is fourth in the nation for winning National Aeronautics and Space Administration grants.

Table 8. Elements of MIE Components at Bowie State University (continued)

Components	Elements
Student Support Initiatives	• The Science, Engineering and Mathematics (SEM) Summer Academy is a voluntary six-week session focused on math, computer science, and "learning-to-learn" skills • In the Science, Engineering and Mathematics (SEM) Fellowship Program, full-time STEM students receive tuition assistance and stipends and mentoring and tutoring from STEM faculty • The Preparation, Resources, and Information in Science, Engineering, and Mathematics (PRISEM) Tutoring and Resource Center provides a centralized peer tutoring resource for all STEM students • Partial assistantships are available for students not eligible for fellowships • As part of the Safety Net Early Intervention Program, retention coordinators monitor all SEM students and refer those that require it to academic advisement • In the Retention in the Sophomore Experience (RISE) program, sophomores who need it receive tuition, academic assistance and faculty mentoring in a summer program designed to help them to catch up with their peers
Undergraduate Research Initiatives	• In addition to the MIE showcase program mentioned above, BSU juniors and seniors are required to make poster presentations at off-campus conferences • Six- to ten-week summer internships provide students with research exposure • Bowie State University Satellite Operations and Control Center (with partners including NASA's Goddard Space Flight Center and Honeywell) gives students operational control over two NASA research satellites, as well as internship and employment opportunities
Faculty Development Initiatives	• MIE-sponsored workshops on integrating research into undergraduate education, active learning strategies, integrating technology into the curriculum, and grant proposal writing • The MIE Faculty Grant Program awards $10,000 grants to faculty to conduct research • The Office of Information Technology (OIT) trains faculty on information technology and its applications • Faculty who are engaged in research with students are rewarded with opportunities for professional development such as funds to pay for travel to conferences

Table 8. Elements of MIE Components at Bowie State University (continued)

Components	Elements
Curriculum Development Initiatives	• MIE funds supported the development of an undergraduate degree program in Computer Technology and a graduate program in Applied and Computational Mathematics • STEM departments adapted courses to a laboratory-based paradigm at the lower division level and an inquiry-based paradigm at the upper division level • STEM professors incorporated the use of formal learning groups in their courses • All STEM departments made an effort to utilize new technology in their courses
Physical Infrastructure Initiatives	• BSU opened a new Computer Science Building in 2003[14] • Five computing labs opened with MIE-funded student tutors and lab monitors • The STEM network connected over 500 computing devices, providing faculty, staff and students with access to high-end servers • In partnership with Apple, BSU is building a Top 100 Super Computer
Graduate and Science Career Initiatives	• Graduate School Preparation Program includes: o 10-week GRE prep course o FOCUS 2003 at Georgia Institute of Technology o North Carolina State Graduate Recruitment Program o University of Pittsburgh's Graduate School Day o Graduate Day Fest at the University of Maryland School of Medicine • Workshops/Colloquia discuss communication and effective presentation skills and writing for the sciences • Students are provided assistance to visit graduate schools and national laboratories

Table 9 highlights MIE component elements in place at two or more project sites. Given the differences between the MIE institutions, it is notable that there is this much commonality among the projects. The reader should be cautious in interpreting this table, however, because tabularization of such complex data oversimplifies it. For example, The University of Texas at El Paso also has outreach to students who may be struggling, with formal freshmen orientation, tutoring and mentoring. It is not included with Spellman College and Bowie State University, however, under the "Special attention to underperforming students" because its program is not as targeted as theirs; at Spellman and Bowie, struggling students are actually individually contacted and invited to receive services.

[14] Although no MIE funds were expended for the construction of this building, some of the scientific equipment and computers with which the classrooms and laboratories were equipped were purchased with MIE funds.

Table 9. Design Elements in Place at Two or More MIEs

Component	Element / Project	UMET	XU	UTEP	OC	SC	BSU
Recruitment and Transition	High-school outreach	X		X	X	X	X
	Summer bridge program	X			X	X	X
Student Support	Freshman orientation	X		X			
	Tutoring	X		X		X	X
	Mentoring	X	X	X	X		X
	Scholarships/Stipends	X	X	X	X	X	X
	Person-to-person attention to underperforming students					X	X
Undergraduate Research	Summer research internships	X	X		X	X	X
	Research opportunities during academic year	X	X	X		X	
	Conference presentation sponsorship	X	X			X	
Faculty Development	Reduced teaching loads for new faculty involved in research	X	X			X	
Curriculum Development	New curriculum	X	X	X	X	X	X
	New emphasis on active teaching	X		X		X	X
Physical Infrastructure	Space/equipment for students	X	X	X	X	X	X
	Laboratory renovations	X	X		X	X	
	Equipment upgrades	X	X		X	X	X
	Classroom renovations				X		
Graduate & Science Career	GRE preparation		X	X			X
	Application preparation support	X			X		

SECTION 4. CONCLUSION

Given its limited timeframe, this study looked at the MIE projects through a particular lens focused on the questions that NSF posed. In general, we found that the projects met the program's goals. STEM enrollment increased between 1997-98 and 2003-04, and generally increased at a faster rate than overall institutional enrollment in each of the MIE-funded colleges and universities. In addition, STEM degrees awarded tended to increase faster in the MIEs than in the Historically Black Colleges and Universities (HBCUs), Hispanic-Serving Institutions (HSIs), and Tribally Controlled Colleges (TCCs) as a group. Even in this modest study, however, we saw clearly that the numbers did not tell the whole story.

Meaningful development of or enhancement to a STEM program takes time, energy, commitment and resources. Faculty development, curriculum development, renovations and new equipment enabled some of the colleges to build and others to enhance their programs significantly. These changes will last long after the MIE funding has stopped, paving the way for a new generation of minority STEM graduates.

Context and Culture in the MIE Institutions

"Communities, and the bonds that tie an individual to them, are created through formal and informal interactions among members. The nature of these interactions is shaped in large part by the beliefs, values, and norms of the cultures in which they are embedded and affect how well integrated their members become… Students who are strongly bonded to their communities are the ones who have been provided with resources that enable them to interact frequently with other members of the community and to engage in the intellectual and professional tasks of the discipline."[15] Although these comments were specific to graduate students, the need for social and academic supports for undergraduates is well established.

The MIE Program targeted MSIs because they most closely reflect the cultures of their constituents. Two of the MIE projects (Spelman and Xavier) were already among the leaders in minority STEM degrees conferred and the other institutions were well positioned to expand their production of diverse minority STEM graduates by instituting or expanding financial, academic, and social services.

Some of the student-centered activities focused on the transition between high school and college, providing an introduction to the campus, campus life, peers and more senior students, faculty, research, collegiate expectations and developmental coursework for those who needed it. In many cases, these activities not only bolstered the students' social and academic adjustment, but changed their own expectations. As one student put it, "Who would have believed that *I* could be a scientist."

Four of the MIE projects (Universidad Metropolitana, University of Texas at El Paso, the Oyate Consortium schools and Bowie) specifically target low-income minority students who may be torn between the responsibilities of school, work and home. These students require comprehensive financial support to allow them to focus on science. In addition, many students at the two HSIs (i.e., Universidad Metropolitana and University of Texas at El Paso) may struggle with English as a second language.

Many of the MIE students are also the first in their families to attend college and often have a harder time in terms of social integration.[16, 17] Consistently, first-generation students perceive their parents to be less supportive of their decision to

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[15] Lovitts, B.E. (2001). Leaving the Ivory Tower: The Causes and Consequences of Departure from Doctoral Study. Lanham, MD: Rowman & Littlefield Publishers, Inc. (pp 82 and 107).

[16] Pascarella, E.T., & Terenzini, P.T. (1991). How college affects students: Are they at greater risk for attrition than their peers are? *Research in Rural Education*, 6(2), 31-34.

[17] National Center for Educational Statistics. (1998). First-generation students: Undergraduates whose parents never enrolled in postsecondary education. Washington, D.C.: U.S. Department of Education. (ERIC Document Reproduction Service No. ED 420 235).

attend college,[18] and they are less likely to receive encouragement from friends outside of college.[19] Mentoring programs, study groups, and academic clustering can provide students with needed social and academic supports.

Low-income and/or first-generation students are also more likely to come to college academically under-prepared and to require more developmental courses, tutoring and mentoring than their higher-income and/or second-generation colleagues. The provision of such services during a summer bridge program or early in their freshman year can help put such students on a level playing field.

> "Whether high school graduates enroll in postsecondary education and whether postsecondary students reach their degree goals depend on many factors, but those whose parents have no education beyond high school are considerably less likely to succeed than those whose parents have completed a bachelor's degree. Students who are nonwhite or from low-income families tend to be disproportionately represented among those whose parents have low education... and parents' education remains significant for gaining access to postsecondary education and for persistence and bachelor's degree attainment at 4-year institutions, even after controlling for other factors such as income, educational expectations, academic preparation, parental involvement and peer influence" (p. 29).[20]

Whether the programs are situated in vibrant urban centers or in remote locations inside Indian country, students bring to MIE classrooms community-based values, beliefs, and perspectives that are expressed in their preferences for thinking and interacting. These culturally determined indices influence not only student learning, but also how students approach schooling in general. Thus, it is important to reflect on how specific contexts and cultures have impacted the MIE projects.

What and how these students are learning in the MIE program is, in large part, why we must pay particular attention to the context. Students who matriculate through the MIE have an advantage; they acquire STEM competencies that are required for the mainstream workforce, but at the same time they are able to utilize skill sets that reinforce their own place-based knowledge system. This dual scheme, as it occurs in local context, does not require the forfeiture or denial of the students' strength, persistence, and validity as a member of a larger distinct culture.

Students learn in ways that are familiar and start their STEM education at whatever point they have achieved. Competencies new to them that will be required for the mainstream workforce are introduced gradually.

[18] Education Resources Institute & Institute for Higher Education Policy. (1997). Missed opportunities: A new look at disadvantaged college aspirants. Boston and Washington, D.C. (ERIC Document Reproduction Service No. ED 420 257)
[19] Terenzini, P.T., Springer, L., Yaeger, P.M., Pascarella, E.T. & Nora, P.M. (1996). First-generation college students: Characteristics, experiences, and cognitive development. *Research in Higher Education*, 37(1), 57-73.
[20] U.S. Department of Education, National Center for Education Statistics (2001). Students whose parents did not go to college: Postsecondary access, persistence, and attainment. Washington, D.C.

Faculties who come from outside these communities do not necessarily arrive with such understandings. For example, professors are often unaware of some of the local taboos (e.g., the appropriate handling and treatment of certain animals and plants in Indian country). However, most of them expressly seek information, take advantage of opportunities to learn local language and culture, and engage in on-the-job training.

Content-specific pedagogy is not the only domain professors must view through a cultural lens, however. In Indian country, for example, local beliefs and values that determine community members' rights and responsibilities also determine local conventions and expectations about how and with whom to interact, under what conditions, and how to do so effectively—all of which have a bearing on successful education. These communitarian sensibilities are grounded in local norms around group success, respect for elders/authority, and hierarchical roles dependent on gender and family background, as well as age. Some of these preferences run contrary to perspectives often taken for granted in the mainstream.

Rather than questioning how one's actions will benefit the group, mainstream U.S. society tends to foster individual thinking and personal choice. Similarly, mainstream roles can be defined in more egalitarian and flexible ways. It can sometimes be confusing for outsiders when students won't speak up in class, won't correct a classmate who misspeaks, or won't initiate discussions about their own individual achievements. However, from the Indian vantage point of interdependence, group ownership, and consensus, standing out from the group in any way is considered rude. Thus, it is important to understand which conditions lay groundwork for student engagement and which do not. For example, one Native professor from OLC emphasized that students have a lot to say and "must be given opportunities to be heard." But rather than asking them to respond to queries on-demand, he allows them the time to provide "thoughtful answers." This educator at first alters wait time to accommodate needed student input, but then introduces routines that bridge to more mainstream conventions that are used in the workplace.

Similarly a number of professors draw from traditional pedagogies that historically utilized observation, group work, and apprenticeship as methods to promote critical thinking, decision-making, and problem-solving. These faculty report that they take advantage of the built-in support systems among students who naturally thrive in small groups and who initiate mentoring of their peers both inside and outside of the classroom.

The Oyate Consortium schools provide the clearest examples of the impact of culture and context in project design and implementation. Serving primarily Lakota and Dakota students from the Pine Ridge, Standing Rock, and Lake Traverse (Sisseton) Reservations, the consortium schools expressly state that reinforcing the traditional values, culture, and language are part of the process of providing quality STEM education. Building on the keen understanding of mathematics and science that have always been a part of Lakota and Dakota teaching and learning, the colleges have designed their STEM programs to address issues of concern to the communities (e.g., land management and conservation biology) and provide students with a culturally embedded education that cultivates leadership and promotes STEM excellence.

The study's research questions must therefore be examined with an understanding of each project's context and culture. Eight distinct institutions forming six MIE projects opened and expanded the world of science, technology, engineering and mathematics to literally hundreds of minority students who have always been underrepresented in these fields. Below, the four research questions that guided this study are addressed.

Question 1. What evidence is there of project success in meeting program goals with respect to student recruitment, retention, graduation and advancement in STEM careers? The MIE institutions have ensured that both faculty and peers are available to every STEM student, providing a real opportunity for success among students who before college could not even imagine themselves as scientists, mathematicians or engineers. STEM enrollments in all MIE institutions increased between 1997-98 and 2003-04. The number of undergraduate STEM degrees conferred and the proportion of all degrees awarded that were in STEM fields increased considerably in five of the MIE projects. STEM degrees awarded tended to increase faster in the MIEs than they did in HBCUs, HSIs, and TCCs as a whole and the group of MIE applicants in general.

Recruitment:

- Outreach to minority elementary, middle and/or high school students (Universidad Metropolitana, the Oyate Consortium schools, Spelman, Bowie)
- Pre-college summer bridge STEM programs (Universidad Metropolitana, Spelman)
- Every MIE project has shown an increase in STEM enrollment from 1997-98 to 2003-04 and in all but Universidad Metropolitana, STEM enrollments have grown at a faster rate than has overall institutional enrollment. (The Oyate Consortium schools had no STEM degree programs prior to the start of the MIE project.)

Retention:

- Developmental courses in writing, math and English (at Xavier) and in Spanish and English (at Universidad Metropolitana)
- College study skills training (Universidad Metropolitana, Bowie)
- Academic monitoring and assistance for freshmen failing STEM courses (Spelman, Bowie)
- Tutoring at all MIEs
- Academic clustering (University of Texas at El Paso)

- Financial aid at all MIEs through scholarships, stipends, and internships
- STEM faculty and peer mentoring at all MIEs
- Research opportunities at all MIEs

Graduation:

- Excluding Spelman, the number of undergraduate STEM degrees conferred and the proportion of all degrees awarded that were in STEM fields increased considerably in all MIE institutions from 1997-98 to 2003-04. (Recall that Spelman had shifted admission priorities which limited STEM growth.)
- Overall HBCU undergraduate STEM degree production fell 4 percent during the period and HSI production increased only by 1.7 percent. In contrast, the undergraduate STEM degrees conferred at MIEs increased 9.4 percent from 1996-97 to 2000-01.

Advancement in STEM Careers:

- Xavier and Bowie offer GRE preparation courses
- Xavier and Universidad Metropolitana provide graduate school application support
- Universidad Metropolitana, the University of Texas at El Paso and Bowie provide networking opportunities to students
- Oglala Lakota has established badly needed STEM-related employment opportunities on the Pine Ridge Reservation, including a small IT company and the first EPA-certified analytical testing lab on a reservation in Region 8
- Spelman, Xavier and Bowie offer workshops on career opportunities

Question 2. What evidence is there of project success in meeting program goals of strengthening institutional infrastructure (i.e., courses, equipment, faculty, etc.)? Across the board, projects appear to have strengthened the infrastructure necessary to educate STEM professionals.

Courses:

- The revamping of existing curricula and development of new STEM curricula reflects extraordinary expansion of STEM course offerings. Examples of these new or revised courses include applied and computational mathematics (Xavier), computer/information technology (Xavier and Oyate), electromagnetic theory (Spelman), environmental science (University of Texas at El Paso and Oyate), and laser optics (Spelman).

Degree Programs:

- New STEM degree programs at the MIEs are shown in Table 24.

Table 24. New STEM Degree Programs at MIE Institutions

MIE		Associate	Bachelor	Graduate
Universidad Metropolitana			• Cellular and Molecular Biology • Chemistry • Environmental Science • Applied Mathematics • Applied Physics • Natural and Tropical Resources • Pre Engineering (Engineering Transfer Program) • Environmental Health • Marine Biology	
Xavier College			• Computer Engineering • Electrical Engineering[21]	
University of Texas at El Paso			• Environmental Science	
Oyate Consortium	**Oglala Lakota**	• Science • Engineering • Math • Life Sciences	• Information Technology • Interdisciplinary Environmental Science	• Natural Resources and Environmental Science[22]
	Sitting Bull	• Environmental Science • Natural Resource Management • Computer Technology		
	Sisseton-Wahpeton	• Computer Systems Technology		
Spelman College			• Physics • Environmental Sciences	
Bowie State University			• Computer Technology	• Applied and Computational Mathematics

[21] Proposed.
[22] Submitted for accreditation.

Equipment and Space:

- Every project has used MIE funds to purchase equipment, especially computers and laboratory equipment. At the Oyate Consortium, MIE funds have enabled the updating or development of the extensive distance learning system.
- Physical renovations have also been very important. The reconfiguration of classrooms at the University of Texas at El Paso enabled the establishment of four student centers for independent and group work. At Oglala Lakota College, renovations at all its sites[23] provided additional classrooms and laboratories. At Universidad Metropolitana, Xavier, the University of Texas at El Paso, Spelman and Bowie, space was created for students to meet, study, and receive tutoring.

Faculty:

> *Over 100 new STEM faculty were hired at the MIE institutions during the period from 1995-2004.*

- The recruitment and hiring of more than 100 new STEM faculty represents huge growth over a short period of time
- Professional development initiatives have been undertaken to increase interactive and participatory modes of teaching and learning (UTEP, Spelman and Bowie)
- The program has fostered the transformation of traditional mind-sets of administrators and faculty, and students themselves, about minority students' potential for success in STEM, especially in the open admissions institutions. Both faculty and students reported that the increase in undergraduate STEM production would have been inconceivable without MIE funds.

This lasting value of changes in the physical infrastructure can not be overstated, whether it meant transition from a trailer that could accommodate only 14 students to a fully integrated, well-equipped classroom lab for 30 at Sitting Bull College or the purchase of a scanning confocal microscope at Spelman. MIE funds were concentrated at every project on the renovation of classrooms and laboratories and the purchase of equipment that will serve STEM students long after MIE funding ends.

[23] Because of the size of the Pine Ridge Reservation, OLC is a decentralized campus, utilizing both distance and on-site education with 12 centers (including 1 in Rapid City and in Allen, Batesland, Kyle, Manderson, Martin, Pine Ridge (2), Porcupine (2), Oglala, and Wanblee on the Pine Ridge Reservation).

Question 3. What project models have been created? What are the major elements in each project? Are there 8 (6) distinct models, core variables?[24] It seems clear that there is one MIE model with seven essential components: recruitment and transition initiatives, student support, undergraduate research, faculty development, curriculum development, physical infrastructure development, and STEM graduate school and employment initiatives.

We believe that the differences observed across the projects can be attributed to their context and culture. Each project looks different due to the extent to which each element was already in place and the emphasis on one or a combination of components over others, but all of the projects address all of the components in one way or the other. The variation logically flows from the unique context and history of each institution. Lending support to the Project BEST design principles, we believe all seven MIE components must be present to promote STEM success—they do not work in isolation from each other. Saying that all seven components must be present is not saying that funding needs to be allocated to each of the seven. As is abundantly clear from the review of the projects, MIE funding was allocated to those critical elements not already in place—or in need of enhancement—and not receiving funds from other sources.

In considering this information, it is important to keep in mind that funded STEM programs other than MIE—some supported by NSF and NASA—are also operating on these campuses at the same time. Some of the components not emphasized in the MIE projects are likely to have been addressed by other means. An obvious example is the major STEM-related building at Spelman, Xavier, and the Oyate Consortium, all of which used non-MIE funds.

Question 4. Are the project models transportable, credible (i.e., do they align with current research models for encouraging diversity within a university)? Can program models be identified to guide national efforts for achieving and sustaining diversity in the STEM workforce? We believe the model is readily transportable, but that it must be aligned to the context and culture of the institution.

Furthermore, we suggest that some components outlined here are essential to create or enhance STEM education at *any* college or university. However, we believe that the single component essential to increase the participation of *minorities* in STEM careers is student support. Saying this does not imply that a program can do without the other components. On the contrary, as we stated earlier, we believe the seven components together are required for a program to be called MIE. What we do mean is that no program can succeed in recruiting, retaining and graduating minority STEM students without sufficient resources to support those students. In many respects, however, all of the MIE components support students.

[24] The numbers "8 (6)" refer to the number of colleges and the number of MIE projects.

The MIE experience suggests that it takes academic, social and financial supports to enable minority students to succeed in STEM careers. Minority students who are low-income, first-generation students are not likely to have the science and math background they will need, and are likely to require developmental courses. They are also not likely to come prepared with the focus and study skills that will be required of them nor to have a really good idea of what awaits them in college. Few will have had the opportunity to meet STEM professionals and to understand what they do. Pre-college orientation that will give them an overview of the college and its amenities, begin to address when and how to study and, perhaps, provide an introduction to an upper classman can go a long way to ease their transition. Meeting faculty and learning a little about what they do is likely to intrigue the students and help them entertain the possibility of a STEM career. Students whose families and friends may not understand the value of college or their ambition to pursue a STEM career will need personal mentoring and peer support to keep working when things get hard.

Our work with the Consensus Panel suggests that the seven MIE model components and many of the elements identified are universal. We believe that wherever they are in place, minorities underrepresented in science, technology, engineering and math can be recruited, retained, graduated, and launched into STEM graduate programs and employment. Furthermore, we see no reason projects like MIE can not succeed in both minority and non-minority institutions, assuming that the latter are willing to hire and retain qualified faculty of color who can serve as mentors and role models to minority students *and* that the school can provide not only the academic but the financial and social supports required for a minority student to excel. In fact, because the seven components cover every aspect of STEM education, we believe that model defines those features that ensure favorable outcomes not just for minority students but for all STEM students in all colleges.

Due to the comprehensive nature of the MIE components, the transportability of the MIE model will be contingent upon the money and time an institution has to plan and implement faculty recruitment and professional development; student recruitment, orientation, remediation and support; and curriculum revision that includes the implementation of course and degree program changes and undergraduate research opportunities as a teaching and learning paradigm. Great strides have been made at the MIEs, but there is more to do and more potential to be captured.

The MIE model can guide national efforts for achieving and sustaining diversity in the STEM workforce. To do so will require what has become apparent in the MIE projects: institutional and individual commitment, a unified and financially supported effort, and hard work over time to transform and build the capacity to sustain success.

The influence of cultural factors that are unique to African Americans, Hispanics and Native Americans that influence their postsecondary success—at MSIs and non-MSIs— bears on-going research. Various perspectives have been put forward on the relationship between culture and minority student persistence. At non-MSIs in particular, engaging minority students through culturally responsive strategies may challenge the most common perceptions about college life, about students, and about cultural differences. A reasonable inference from the MIEs is that faculty attitudes toward minority students and their cultures can positively influence the students' STEM achievement. The impact of the race- and ethnic-specific contexts of the MIEs suggests the importance of further study considering unique cultural interventions that may be relevant to minority student retention in STEM at all institutions.

STEM faculties also have their own cultures. STEM faculty greatly influences minority STEM students. There is a need to explore what factors contribute to or impede supportive faculty and departmental cultures, i.e., what works against or can contribute to a STEM faculty culture that ensures minority student success at both MSIs and non-MSIs.

Summary

This paper presented information related to an AIR time-limited impact evaluation of a program designed to increase the number of underrepresented minorities in science, technology, engineering and mathematics (STEM) through funding to a select group of minority-serving institutions (MSIs).

The six MSIs specifically target low-income students who are often the first in their families to attend college. Many come from culturally and ethno-linguistically distinct communities not strongly reflected among the faculty. Differences in the MSIs' size, history, population, financial situation, other funding and the strength of existing STEM programs were reflected in differences in the projects implemented and led to differences in program impacts that needed to be addressed in the evaluation.

This paper reflected on the impact of culture and context on the program and on its evaluation, with specific examples of the issues addressed by particular MSIs and illustrations of how the evaluation dealt with differences in program designs and outcomes.

The goal of evaluation historically has been to assess whether or not intervention X resulted in Y impact. That is still important. More recently, however, evaluators have come to understand that there is a much larger—and sometimes more important—story to tell. In pursuit of 'rigor,' an evaluation may oversimplify the process, ignoring the host of intervening factors and complex systems in which the interventions are embedded.[25]

More and more, evaluators are striving for cultural competence, a set of congruent behaviors, attitudes, and policies that come together in a system, agency

[25] Endo & Joh (Winter 2003) *Multicultural health evaluation: Shifting our thinking: Moving toward multicultural evalution.* Woodland Hills, CA: The California Endowment..

or among professionals and enable that system, agency or those professionals to work effectively in cross-cultural situations.[26] In that effort, they must understand the cultural nuances that “disassemble the expectations and tools of the majority when applied to the minority.”[27]

This evaluation involved both within and cross-site analysis of one program implemented in six remarkably different contexts. Because of differences in the institutions’ history, infrastructure, size, economic situation, and population served, the projects looked remarkably different. Viewing them in context, however, enabled the underlying model to be identified and to determine that there was, in fact, only one program being delivered, appropriately modified to address the specific areas of weakness it was intended to bolster at each site.

The report this paper draws from documents the efforts taken to ensure that the story told by the evaluation accurately captured the context and culture of the grantees and showed the impacts of a wide variety of contextual factors on the program design and implementation at each site. We were able to discuss the extent to which intervention X resulted in Y impact but also to explore how and why these results were achieved, for whom, and under what circumstances.

[26] National Center for Cultural Competence

[27] Eric Jolley, quoted in National Science Foundation (2002). *Cultural context of education evaluation: A Native American perspective.* NSF 02-057)