Quality Education for Minorities (QEM) Network

Effective Institutional STEM Instructional Strategies at HBCU-UP Grantee Institutions

Supported by the National Science Foundation (NSF)

December 2012
Quality Education for Minorities (QEM) Network
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INTRODUCTION

The Historically Black Colleges and Universities Undergraduate Program (HBCU-UP) at the National Science Foundation (NSF) provides awards to Historically Black Colleges and Universities (HBCUs) to develop, implement, and study evidence-based innovative models and strategies to better prepare HBCU undergraduate students to pursue science, technology, engineering, and mathematics (STEM) graduate programs and/or careers.

With NSF support, the Quality Education for Minorities (QEM) Network conducted a workshop on November 9-10, 2012, on Evidence-based STEM Instructional Strategies at HBCU-UP grantee institutions. The goals of the workshop were to:

• enhance the participants’ awareness and understanding of the methodologies for assessing and evaluating the effectiveness of STEM instructional practices; and
• share information on Evidence-based STEM instruction practices being used at NSF/HBCU-UP grantee institutions.

Workshop sessions included discussions on the meaning of evidence–based reforms and on characteristics of successful STEM instructional strategies. A copy of the workshop agenda is given in Appendix A.

In August 2012, QEM recruited two-person teams consisting of a STEM and an Education faculty member by sending invitations to HBCU faculty who participated in the following QEM/HBCU-UP-funded activities: STEM and Education faculty from the Broadening Participation in STEM Education Research Proposal Development workshop in December 2011; STEM faculty participants from the Leadership Development Institute (HBCU-UP LDI), Cohorts I and II; and STEM faculty members who are participating in the Professional Development and Mentoring (PDM) component of QEM’s HBCU-UP-funded Education Research Project. Invitations also were sent to 19 other HBCUs with active HBCU-UP awards.

Forty-two (42) two–person teams participated in the November workshop, representing 31 different HBCUs from 14 states, the District of Columbia, and the Virgin Islands. A list of participants can be found in Appendix B. Biographical sketches of workshop presenters are provided in Appendix C.

As a condition of their attendance, the faculty teams were required to provide templates describing the instructional strategies used at their institutions and evidence of the strategies’ effectiveness in advance of the workshop. QEM staff then organized participants into groups based on the instructional approaches provided. Four strands were identified and used to form the concurrent session group strands: Mathematics and Computer Science; Peer-Led Tutoring/Teacher Preparation-focused; Student-centered; and Technology-enhanced.
QEM staff also reviewed the templates in advance of the meeting to generate a glossary of instructional strategies, assessment methodologies, and instruments, which was included in the workshop meeting packet. The glossary can be found in Appendix D.

While at the workshop, participants actively engaged in conversations with presenters and with their peers to revise their submissions as necessary and to add assessment and evaluation methods. Included in this booklet are the 51 instructional strategy templates. Many were revised based on knowledge gained from attending the workshop and resubmitted for inclusion in this booklet. The templates reflect a wide range of approaches being pursued at HBCUs to improve the preparation and success of undergraduate students in STEM.

On the second day of the workshop, participants reviewed highlights from Day One. These discussions resulted in the idea of a resource center to further the workshop’s goals. When asked if the idea of such a Center was a good one, participants overwhelmingly responded “yes.” QEM agreed to develop and distribute a brief survey about the proposed center to workshop participants. Results of the survey will be provided to program participants and to NSF program officers.

This material is based upon work supported by the National Science Foundation under Grant No. 917335. Any opinions, findings, and conclusions or recommendations expressed in this material are those of the author(s) and do not necessarily reflect the views of the National Science Foundation.
Quality Education for Minorities (QEM) Network  
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Mathematics and Computer Science Strand
Quality Education for Minorities (QEM) Network
Effective Institutional STEM Instructional Strategies at HBCU-UP Grantee Institutions

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Brief Description of STEM Instructional Strategy: In addition to a brief description of the strategy, include discipline; course; target student group (classification); and duration of intervention (summer, fall semester, spring semester, full academic year).

The strategy under investigation is the use and effectiveness of online mathematics software called Educosoft as a learning strategy to teach freshmen taking College Algebra. College Algebra is a general education requirement, and so it is required across all academic disciplines. This course is taught in the mathematics department, and has been taught with electronic software for the past 6 years with a 60% success rate—students earning grade C or higher.

Brief Description of Institutional/Departmental (Non-anecdotal) Evidence of Strategy’s Effectiveness:

In the past, Central State’s success rate for students taking College Algebra remained consistently around 50%. In 2004, the mathematics department received a grant from the U.S. Department of Education’s Minority Science and Engineering Improvement Program to utilize blended instruction—integrating electronic learning (Educosoft) with traditional lecture methods—to increase students’ success rate in College Algebra. By 2007, blended instruction was incorporated into every College Algebra course, and the overall student success rate increased to 60%. However, since then, the success rate has remained around 60%, demonstrating that electronic learning cannot be used independently in the classroom to yield continued academic success. Thus, additional strategies and techniques must be integrated into the classrooms to meet the needs of minority students and yield higher success rates in College Algebra.

Brief Description of Assessment Strategies of STEM Instructional Practices: Non-traditional assessments such as graphic organizers, articulation rubrics, analysis rubrics, and procedural charts will be employed to assess student learning through the use of electronic software. These tools will be designed and implemented in collaboration with math education faculty. The online system, Educosoft, presently assesses the following:
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Institution: Central State University Cont’d

- students’ use of the online materials—accessing lecture notes, additional uploaded materials, homework, and exams
- students’ length of time to complete assignments and examinations
- students’ frequency of attempts to arrive at a correct solution per problem
- students’ missed problems, organized by topic

Although Educosoft provides these assessments, it does not provide a thorough assessment of student understanding. Thus, the non-traditional assessments proposed are intended to gauge student learning more frequently and in more depth.

Brief Description of Evaluation Strategies of STEM Instructional Practices: Students and instructors will be surveyed in order to determine the perceived effectiveness of blended instruction and online learning. The surveys will be designed, conducted, and evaluated by an external evaluator.
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Institution: Dillard University Team 2

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**Brief Description of STEM Instructional Strategy:** In addition to a brief description of the strategy, include discipline; course; target student group (classification); and duration of intervention (summer, fall semester, spring semester, full academic year).

STEM literacy and critical-thinking are two important components to America’s current educational reform agenda. **Our STEM instructional strategies include inter-disciplinary instruction, reasoning, literacy and more real life problems in teaching a university core course—Math 121-College Algebra—to a target group of freshmen during the full academic year.** To implement these strategies, many STEM instructional activities are added to our teaching and learning process, such as “Weekly Math Game,” “Mathematics in Our Daily Life Thesis Competition,” “Math Chapter Case Study,” “Algebra Relay,” “Rap on My Math Errors,” and so on.

**Brief Description of Institutional/Departmental (Non-anecdotal) Evidence of Strategy’s Effectiveness:**

Evidence of Strategy’s Effectiveness:
- Math 121-College Algebra has been become a core course in DU Curriculum for every major at Dillard
- Passing rate of Math 121-course of freshman students is increased
- Percentage of students’ participation for Algebra Relay, Undergraduate Research, National Undergraduate Research Conferences and so on

Evaluation of Project:
- Number of participants
- Passing rate of College Algebra, Math 121
- Number of out-of-Math class activities
- GPA of students participating in out-of-Math class activities
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Effective Institutional STEM Instructional Strategies at HBCU-UP Grantee Institutions

Institution: Grambling State University

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**Brief Description of STEM Instructional Strategy**—In addition to a brief description of the strategy, include discipline; course; target student group (classification); and duration of intervention (summer; fall semester, spring semester, full academic year).

**STEM introductory courses in computer science, chemistry, engineering technology, and physics have been redesigned to include inquiry-based and/or problem-based learning strategies to engage incoming students in collaborative, cooperative techniques for learning concepts and problem solving.** The lower level STEM courses are taught using inquiry-based projects and problem-based learning; these activities include semester-based projects designed to provide real world problems to students in order to produce creative, effective solutions. These courses are:

- **Computer Science:** Introduction to Computer Science I and II (CS 110 and CS 120). The methodology is reinforced at the sophomore level with a course in Data Structures (CS 235).
- **Mathematics:** Pre-calculus (MATH 147 and MATH 148) include a one-hour laboratory practice for problem solving.
- **Chemistry:** General Chemistry I and II (CHEM 111, 112) include process-oriented learning strategies that involve a guided approach to problem solving and quantitative reasoning strategies in addressing word problems.
- **Engineering Technology:** Introduction to Engineering Technology (ETC 101) and Engineering Graphics (ETC 103) include problem-based learning approaches designed to develop presentation skills and team work early on in the curriculum. Graphic presentations with the use of Computer Aided Design methods are emphasized.
- **Physics:** General Physics I and II (PHY 153, 154) include the use of literature-based topics that relate to current advancements. Topics are selected that include the use of nanoscience and technology in present day challenges. Students are guided by connecting fundamental concepts/topics covered in a general (introductory) physics course with present day advancements found in the literature.

In all these courses the instructional strategies involve computer-based problem solving activities, including the experimental laboratories in chemistry. We incorporate brainstorming processes for all team projects. The assessments of student work allow identifying the deficiencies in problem solving methodology and encourage team work and concept building strategies. Students are also introduced to undergraduate research beginning the sophomore year, in general. This gives our students the opportunity to present their research findings in workshops and conferences. Summer internships and academic research activities are part of the learning process.
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Institution: Grambling State University Cont’d

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<td>Grambling State University has established a Center for Mathematical Achievement in Science and Technology (CMAST) program to enhance problem-based learning. Students are recruited in this program and provided the guidance to improve the course standards and student retention. As a result, the retention in computer science has improved from 40% passing rate to 66%. Additionally, the Quality Education Program (QEP) was introduced to improve the mathematical skills of all students through a pre-calculus course (MATH 147).</td>
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Institution: North Carolina A&T State University Team 1

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Brief Description of STEM Instructional Strategy-
In addition to a brief description of the strategy, include discipline; course; target student group (classification); and duration of intervention (summer, fall semester, spring semester, full academic year).

The amount, diversity, and complexity of data have been growing at unprecedented rates over the recent years. A constraint on extracting meaningful information from such data is a significant shortage of skilled technical and analytical specialists, who can effectively structure, analyze, and interpret the analyzed results. In addition, the workplace is changing and demanding a higher level of skills, than ever before. To ensure that college graduates succeed in the modern workplace, it is essential to prepare them with both academic skills, as well as the ability to apply their knowledge and skills in the workplace. To address the national shortage in this workforce and to expand the pipeline that produces students for careers in data science, we will coordinate a student-focused experience-based program, which will be called the Pipeline for Data Science (PDS) Program. Its purpose would be to assist students who enter the School of Technology at North Carolina A&T State University (NCA&TSU). We would encourage and support them to complete a series of data analysis courses from freshmen to senior year, to be fully equipped to join the 21st century workforce. We would also urge them to pursue an advanced degree to further qualify them for a higher position in the workforce.

The selected courses will adopt the Project-based Learning method to encourage students to solve problems collaboratively through group projects. These projects are designed to encourage students to take responsibility for forming a team and then working in a group to select a project topic. They not only learn the theories to effectively manage data but they also have to determine which method to apply to their projects. By doing this, students develop critical thinking and problem solving skills. Using these skills the student can then learn to apply data management methodologies in a diversity of disciplines, to solve problems both independently as well as to contribute to a team, and to become a life-long learner.

To increase the number of students who pursue and succeed in careers related to data science, we also plan to offer a summer enrichment program to students in grades nine through twelve. This program is geared to attract nontraditional students to the technology field. The need to increase the number of nontraditional students in fields related to data science is apparent due to the underrepresentation of women and minorities among professionals in these careers. Ultimately, the project seeks to provide a pipeline of diverse students participating in technology school programs.
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Institution: North Carolina A&T State University Team 1 Cont’d

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<td>North Carolina A&amp;T State University (NCATSU) has always been a leader in graduating African American engineers and technologists who help fill the national need for a diverse scientific and technological workforce. The School of Technology at NCATSU is the second largest in STEM enrollment. The goal of the school is to train students with the best up-to-date theoretical knowledge and applicable skills, as well as help students gain an understanding of workforce daily operations. Courses and laboratory experiences in the school provide students with an active and progressive learning environment and relevant technological curriculum.</td>
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Data collection will consist of various methods. A survey will be developed that will consist of a pre/post questionnaire. The students will be evaluated on their final project reports to assess their problem solving and critical thinking skills. Observations of the instructors and teaching assistants will be included in the assessments. The evaluation/projected outcomes will be inclusive of a goal-based, processed-based, and outcome-based survey evaluation.
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Institution: Savannah State University

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Brief Description of STEM Instructional Strategy- In addition to a brief description of the strategy, include discipline; course; target student group (classification); and duration of intervention (summer, fall semester, spring semester, full academic year).

**Vygotsky’s “Zone of Proximal Development” as Teaching Strategy to Enhance College Algebra, Pre-calculus and Calculus I Teaching and Learning**

Because problems of human teaching and learning are psychological problems, it is reasonable to select an aspect of educational psychology and developmental psychology as a teaching strategy to enhance the teaching and learning of college algebra, pre-calculus and calculus I courses. The American Psychological association, Division of Educational Psychology defines educational psychology as:

- The branch of psychology that is concerned with the development, evaluation, and application of (a) theories and principles of human learning, teaching, and (b) theory-derived educational materials, programs, strategies, and techniques that can enhance lifelong educational activities and processes (Wittrock & Farley, 1989, p. 196).

Effective teaching which promotes learning involves an understanding of the learning theories that form the bases for the different methods of instruction. A teacher may draw methods of instruction from behavioral theories, cognitive theories, social learning theories, attribution theory, achievement motivation theory, as well as using concepts from Piaget or Vygotsky. Thought processes such as thinking, understanding, and perceiving have been emphasized by the developmental theories of Piaget and Vygotsky. These two theorists express theoretical perspectives on how a child develops. Piaget’s Constructivist Theory of Cognitive Development, when applied to learning, is summarized as follows:

- As Piaget correctly taught us, children’s cognitive structures dictate both what they accommodate and notice in the environment and how what is accommodated to is assimilated [interpreted]. The active nature of their intellectual commerce with environment makes them to a large degree the manufacturers of their own development (Flavell, 1994).
- The Zone of Proximal Development is one of the three components in Lev Vygotsky’s theories. It is “the distance between the actual developmental level as determined by independent problem solving and level of potential development as determined through problem solving under adult guidance or collaboration with more capable peers” (Vygotsky, 1978, p. 86).
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Institution: Savannah State University Cont’d

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<td>All students who registered for the listed courses took a diagnostic test at the beginning of each semester to determine the level of preparedness of each student. Based on the test score, the prescribed course syllabus is revised. In addition to recitation, tutorials are offered before and after each quiz and end-of-chapter test. Students who scored less than 70% on each quiz or test were given additional tutorial and shall be retested. To monitor student learning, each chapter subsection is accompanied by an on-line homework assignments. An average score of 70% or better is a prerequisite to sit for end-of-chapter test. The data collected from homework assignments, quizzes, tests, and final examination shall enable the pupils to track their progress in attaining the prescribed course completion criteria. It also enables the institution make decision whether a pupil has meet the prerequisite knowledge and skills required to register for a higher level course and enables the instructor maintain or revise the teaching strategy in the future. The summative evaluation shall enable the mathematics department reconstruct the curriculum of each course to align it with the basic mission of the university.</td>
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Brief Description of STEM Instructional Strategy- In addition to a brief description of the strategy, include discipline; course; target student group (classification); and duration of intervention (summer, fall semester, spring semester, full academic year).

In preparing students to strengthen their reasoning and logical skills in higher level mathematics, it has been suggested to integrate more writing in the mathematics courses beginning with the Calculus sequence. This strategy will consist of having students keep a mathematics journal. Students will be given a mathematics problem to solve, writing out all of their steps and mathematical reasoning to solving the problem. The target student group will be mathematics majors or other majors requiring Calculus 1, 2, and 3. The implementation will begin Spring 2012 in a Calculus 2 course and will last for the duration of the semester.

Brief Description of Institutional/Departmental (Non-anecdotal) Evidence of Strategy’s Effectiveness:

A rubric will be given to the students with the journal entry requirements. A survey at the end of the semester will be administered to determine if the addition of the mathematics journal contributed to a deeper understanding of the concepts in the course compared to their Calculus 1 understanding.
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Institution: Talladega College, Submission 1  

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Brief Description of STEM Instructional Strategy- In addition to a brief description of the strategy, include discipline; course; target student group (classification); and duration of intervention (summer, fall semester, spring semester, full academic year).  

The current generation of students is highly engaged in the use of social media, texting, chatting, and browsing. As educators, we need to recognize this and find ways to use the technological advances to make meaningful impacts on students’ learning. Talladega College recognizes the role that technological advancement can play in the process of teaching and learning, and uses the trends to teach this “New Generation of Students.” Therefore, utilizing support from the Historically Black Colleges and Universities- Undergraduate Program (HBCU-UP), the Mathematics Department was able to convert a classroom in Silsby Science Hall into a Mathematics Teaching and Learning Laboratory. The Laboratory is equipped with twenty-four computers, a remote screen, ceiling mounted projector, and a teacher workstation.  

Since its opening, the Lab has been serving as a major teaching and learning resource. The Math Lab has been used as follows:  
• To conduct hybrid classes; these are mostly freshman classes which are conducted through interactive educational software such as EducoSoft.com and MyMathlab.com. Students purchase access codes, which include an e-book, tutorials, examples, and exercises from a designed vendor to access the learning resources. During class time, the teacher introduces the day’s topics and objectives of the lesson then let the students log in to the web page using their access codes. Thereafter students take the stage and the teacher helps by answering questions and by pointing out the main ideas of the particular topic.  
• To teach traditional lecture classes supported with online resources; there are many resources on the internet which, if used widely, can help execute effective student learning:  
  o Lecture notes are online, and during class, students are expected to pull notes from the school web page (myTalladega.edu), which gives more time for discussion.  
  o Active online interactive learning:
Institution: Talladega College, Submission 1 Cont’d

- Some mathematical concepts may not be easily grasped by students even after a number of repeated trials. In situations like these we use YouTube.com as one resource. The beauty of YouTube is, there are several lectures to choose from and once one makes the selection one can repeat it as many times as needed.
- Another online resource that we use frequently in the Math Lab is free online graphing calculators. In teaching mathematics, pictures or graphs are the best means used to convey ideas; as such, we require a graphing calculator for a number of courses. Online graphing calculators are free, which helps reduce student expenses.
- Mathematica; the Math Lab is also equipped with Mathematica Software to help students better learn mathematical concepts in calculus, geometry, differential equations, or other applied sciences.

**Brief Description of Institutional/Departmental (Non-anecdotal) Evidence of Strategy’s Effectiveness:**

Talladega College Department of Mathematics
Students Performance Chart for Blended (Hybrid) and Traditional Classes

Academic Year: 2011-2012  
Semester: Fall 2011  
Course: Introduction to Mathematics I  
Class: MTH 101C  
Total of students registered for the class: 30

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<th>With EducoSoft Access Codes</th>
<th>With No EducoSoft Access Codes</th>
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<tr>
<td>Total Number of Assessments:</td>
<td>HW, Quizzes, Tests, etc. given</td>
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<td>Number of A’s</td>
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</tr>
<tr>
<td>Number of B’s</td>
<td>3</td>
<td>0</td>
</tr>
<tr>
<td>Number of C’s</td>
<td>3</td>
<td>0</td>
</tr>
<tr>
<td>Number of D’s</td>
<td>1</td>
<td>3</td>
</tr>
<tr>
<td>Number of F’s</td>
<td>2</td>
<td>11</td>
</tr>
<tr>
<td>Number of I’s and W’s</td>
<td>1</td>
<td>1</td>
</tr>
</tbody>
</table>
Effective Institutional STEM Instructional Strategies at HBCU-UP Grantee Institutions

Institution: Talladega College, Submission 1 Cont’d

Academic Year: 2011-2012
Semester: Summer 2012
Course: Introduction to Mathematics I
Class: MTH 101A
Total of students registered for the class: 16

<table>
<thead>
<tr>
<th></th>
<th>With EducoSoft Access Codes</th>
<th>With No EducoSoft Access Codes</th>
</tr>
</thead>
<tbody>
<tr>
<td>Number of Students</td>
<td>16</td>
<td>0</td>
</tr>
<tr>
<td>Total Number of Assessments:</td>
<td>47</td>
<td>0</td>
</tr>
<tr>
<td>HW, Quizzes, Tests, etc. given</td>
<td></td>
<td></td>
</tr>
<tr>
<td>Number of A’s</td>
<td>3</td>
<td>0</td>
</tr>
<tr>
<td>Number of B’s</td>
<td>8</td>
<td>0</td>
</tr>
<tr>
<td>Number of C’s</td>
<td>3</td>
<td>0</td>
</tr>
<tr>
<td>Number of D’s</td>
<td>0</td>
<td>0</td>
</tr>
<tr>
<td>Number of F’s</td>
<td>2</td>
<td>0</td>
</tr>
<tr>
<td>Number of I’s and W’s</td>
<td>0</td>
<td>0</td>
</tr>
</tbody>
</table>
Brief Description of STEM Instructional Strategy—In addition to a brief description of the strategy, include discipline; course; target student group (classification); and duration of intervention (summer, fall semester, spring semester, full academic year).

The Department of Computer Science at TSU provides a JAVA boot camp for selected number of students from TSU and some other HBCUs. The Boot Camp has 5 hours of lectures for seven straight days including Saturday and Sunday from 8am to 1pm. The participants then attend another 5 hours of laboratory sessions every day from 2pm to 7pm. The students are selected using a qualifying exam prepared by the Department. The exam is administrated by an instructor at each institution and graded by the TSU Computer Science Department. The lectures are extremely interactive and challenges students’ critical thinking abilities.

Brief Description of Institutional/Departmental (Non-anecdotal) Evidence of Strategy’s Effectiveness:

- The participants took the “Oracle Certified Professional for Java SE 5” exam, which is administrated by Prometric Services. Fifteen of the participants passed the exam on their first attempt (79% passing rate) in 2011. The passing rates were similar in 2010, 2009, and 2008.
- The student surveys indicate the success of the program.
- The job placements of the certified students indicate the effectiveness of the program.
Quality Education for Minorities (QEM) Network  
Effective Institutional STEM Instructional Strategies at HBCU-UP Grantee Institutions

Institution: Texas Southern University

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**Brief Description of STEM Instructional Strategy**  
In addition to a brief description of the strategy, include discipline; course; target student group (classification); and duration of intervention (summer, fall semester, spring semester, full academic year).

*In Spring 2013 the mathematics department, in collaboration with the college of education, will implement the STEM Enrichment Program (SEP) for the academic enhancement and retention of undergraduate students perusing STEM degrees. Based on the Collaborative Learning Model, SEP’s hallmark will be the creation of a learning community for students in high-risk classes, with workshops designed to enhance learning and problem-solving skills.*  
The objective of SEP will be to increase retention rates and decrease withdrawals and failures, with its students consistently earning higher grades as a group compared to non-SEP students. The second objective of the program will be to increase graduation rates in STEM fields. The program will begin by focusing on Math 136 (Pre-calculus) in the spring. In the fall 2013, the program will be expanded to support students enrolled in other gateway science and mathematics courses, such as Calculus, Chemistry, and Physics. Pre-calculus is being targeted because of its gateway potential, and pass rates of students previously enrolled in this course have hovered around sixty percent.

The major component of SEP will be to provide workshop classes, with a small class size to support STEM majors early in their academic careers. Students will be encouraged to collaborate in small groups as they work on daily assignments, challenging supplemental materials such as worksheets, and mock exams. Integrated into these workshop sessions will be strategies on how to learn, what to learn, note taking, test preparation, and other elements essential for success.

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**Brief Description of Institutional/Departmental (Non-anecdotal) Evidence of Strategy’s Effectiveness:**

The STEM Enrichment Program (SEP) is modeled after two programs established at University of California, Berkeley and University of Houston. Both programs have had a significant impact on increasing retention rates in STEM fields for minority students.
Quality Education for Minorities (QEM) Network
Effective Institutional STEM Instructional Strategies at HBCU-UP Grantee Institutions

Institution: Tuskegee University

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**Brief Description of STEM Instructional Strategy:** In addition to a brief description of the strategy, include discipline; course; target student group (classification); and duration of intervention (summer, fall semester, spring semester, full academic year).

**Undergraduate teaching assistants (UTAs) were hired to assist with instruction in Math 107 (College Algebra and Trigonometry 1) for the 2011-2012 academic year.** They were selected in the following manner. The UTAs were referred by the mathematics faculty. STEM majors and students who had taken at least Calculus 1 were then considered. In order to be selected students had to have earned A’s or B’s in Calculus 1 and the courses that were taken prior to it. Each student considered had to have at least a 2.75 grade point average. Students whose names were selected through the above process were interviewed and were asked basic questions regarding mathematics topics. In addition, they were asked to describe how they envisioned working with students.

Each week the UTAs met with the teacher with whom they were working and they were required to turn in a written report of their activities signed by that teacher. Student comments were also considered, and if students reported a negative experience with a tutor, that was reported to the program’s administrator.

The UTAs made themselves familiar with the students and teachers’ teaching methods through weekly attendance in that teacher’s Math 107 course. They made themselves available for office hours and tutoring lab sessions required for students who failed the previous exam. Teachers provided work for the UTAs to use with the students during the Wednesday Lab sessions. Each teacher worked with his or her UTA regarding the material and manner in which the UTA would work with the students.

**Brief Description of Institutional/Departmental (Non-anecdotal) Evidence of Strategy’s Effectiveness:**

In the fall of 2010, when UTAs were not used, the passing rate for Math 107 students with A’s, B’s, and C’s was 57.79% and for students with A’s, B’s, C’s, and D’s was 74.09%. The following fall, 2011, when the UTAs were used, the passing rate for Math 107 students with A’s, B’s, and C’s was 65.48% and for students with A’s, B’s, C’s, and D’s was 79.89%.
Specifically, the breakdown was as shown in the following table:

<table>
<thead>
<tr>
<th>Grade</th>
<th>Math 107 % Fall 2010</th>
<th>Math 107 % Fall 2011</th>
</tr>
</thead>
<tbody>
<tr>
<td>A’s</td>
<td>17.61%</td>
<td>23.94%</td>
</tr>
<tr>
<td>B’s</td>
<td>16.30%</td>
<td>20.11%</td>
</tr>
<tr>
<td>C’s</td>
<td>23.87%</td>
<td>21.43%</td>
</tr>
<tr>
<td>D’s</td>
<td>16.30%</td>
<td>14.42%</td>
</tr>
<tr>
<td>F’s</td>
<td>24.89%</td>
<td>19.31%</td>
</tr>
</tbody>
</table>

Beyond this evidence, faculty members reported that students who made use of the UTA labs found it helpful. Comments include:

- “I am receiving . . . very positive feedback from my students concerning UTAs.”
- “The two young ladies who were my TA’s made themselves actual stakeholders in the success of our students.”
- “All of the students who go to the UTAs for help express the feeling that they are helpful.”

One faculty member also administered a survey in which 24 out of 26 respondents found the UTAs either helpful or somewhat helpful and none of the respondents said that they never found the UTAs to be helpful. Among the comments students made were:

- “I believe the UTA is very helpful because it allows the student to ask more questions if he/she is too afraid to ask the teacher.”
- “She helps on Wednesdays and she explains it well.”
- “I enjoy the tutor’s help. She is informative and has her own special way of doing that.”

Assessment and Evaluation: Should we receive funding for further implementation of UTAs, we can improve upon the assessment and evaluation included in the project described above as follows.

- Solicit student evaluations of the UTA’s effectiveness during and at the end of the semester. Include both quantitative and qualitative data.
- Solicit faculty evaluations of the UTA’s effectiveness during and at the end of the semester. Include both quantitative and qualitative data.
Quality Education for Minorities (QEM) Network
Effective Institutional STEM Instructional Strategies at HBCU-UP Grantee Institutions

Institution: University of Arkansas at Pine Bluff

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William Torrence
Chair
Department of Health, Physical Education, and Recreation
Phone: 870/575-8697   Email: torrencew@uapb.edu

<table>
<thead>
<tr>
<th>Brief Description of STEM Instructional Strategy- In addition to a brief description of the strategy, include discipline; course; target student group (classification); and duration of intervention (summer, fall semester, spring semester, full academic year).</th>
</tr>
</thead>
<tbody>
<tr>
<td>To increase the pass rate of STEM students in Gatekeeper Courses the following strategies have been implemented: mandatory supplemental instruction by instructors and peer tutors (Mathematics, Biology, Chemistry, Physics); development of an Enhancement Lab for students that make a grade of ‘C’ or less on any exam taken during the course (Industrial Technology Management &amp; Applied Engineering); redesign of Mathematics course where students work at their own pace and must exhibit 80% proficiency on all mathematics concepts for each module (these students will be assisted with student tutors and the ‘I Can Learn’ software). These strategies are ongoing.</td>
</tr>
</tbody>
</table>

<table>
<thead>
<tr>
<th>Brief Description of Institutional/Departmental (Non-anecdotal) Evidence of Strategy’s Effectiveness:</th>
</tr>
</thead>
<tbody>
<tr>
<td>Some preliminary results include the following: higher pass rates on course exams, students in the blended mathematics course are completing developmental mathematics and college algebra at a faster rate.</td>
</tr>
</tbody>
</table>
Quality Education for Minorities (QEM) Network  
Effective Institutional STEM Instructional Strategies at HBCU-UP Grantee Institutions

Institution: Winston-Salem State University Team 1

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**Brief Description of STEM Instructional Strategy**  
In addition to a brief description of the strategy, include discipline; course; target student group (classification); and duration of intervention (summer, fall semester, spring semester, full academic year).

Introduction: To improve student learning in the STEM disciplines, traditional pedagogical approaches are not enough to transfer critical knowledge to students. One of the major reasons for low retention rate in STEM fields might be related to how we teach and how we assess student learning. A closed loop, feedback-driven evidence-based teaching and learning technique has to be devised and implemented in our classes to improve student retention rates in the STEM discipline.

Need for evidence-based learning: Lecturing is one of the most widespread forms of classroom instruction delivery technique. A fundamental problem of traditional lectures is that, although they are 60 to 75 minutes long, students only have an attention span of 20 minutes. This problem is exacerbated in recent years by the proliferation of mobile computing devices in the classroom. Having such computing devices allows the students to swerve their concentration into something other than what the class is covering. Even if the students do that only a fraction of the class time, they might miss important aspect of the lecture that will later hamper their problem solving skills. In such a class setting, quizzes and exams are one of the most effective ways to assess student learning. However, since such quizzes and exams are administered sparsely across the semester, it is extremely difficult to synchronize content coverage and student learning. By administering only standard quizzes and exams in a course, faculty might not fully gauge student learning and have any chance to improve student learning during the semester.

Strategy used: **Short quizzes were introduced at the end of every class, which gave immediate feedback on student learning.** Each short quiz spanned ten minutes and was administered at the end of a 60-minute lecture and a 5-minute break/discussion time (total class time was 75 minutes). Each short quiz asked one or two analytic/reasoning questions from the content covered in the first 60 minutes of the class. This way, I am able to make sure that students understand the content covered in that class. This also allows me to see whether I have to repeat anything from that class to reinforce the learning. I allow these quizzes to be open notes. That also serves another important purpose: since students know that there will be an open-note quiz at the end, they concentrate more in lectures, actively participate in class discussion and critically take notes. So, beginning of each class, we discuss the short quiz of the previous class to keep the class in-synch with the content covered. This way, I can see which students are struggling right away and can work with those students in one-to-one, out-of-class tutorial sessions.
Continuous Improvement: Teaching is an art to encourage students to become active learners and to inspire them to take responsibility for their own learning. I believe that, by actively reviewing, collaborating, learning and improving teaching style, one can master this art. Therefore, at the end of the semester, I look at the student feedback and individual assessment items and re-design the course to accommodate the course dynamics. This way I strengthen the teaching methodologies that worked and either discard or improve the ones that did not work as planned. I think that improving one’s teaching effectiveness is a continuous process and a real-time adjustment based on student feedback, peer observation and self-reflection is crucial to creating a well-organized style of teaching with clear goals and plans to ensure student success.

Discipline: Computer Science Course: CSC 2320: Introduction to Computer Hardware Organization. This course introduces students to the bare bones of digital electronics and the foundation of computers. Students are confronted for the first time in their lives with logic-based computation and are eventually elated to see how gratifying it is to create one’s own electronic circuits. I used this course as a stepping stool for the students to build a mental model of a ‘computing machine’ for later use in my junior and senior courses. Students get to learn how basic building blocks of computer hardware are manufactured and how they can use those building blocks to make a whole computer. My belief is that this course is crucial to awakening students’ enthusiasm about the nuts and bolts of computers so that they can gain self-confidence in mastering a complex idea with ease. This will later empower those students to approach more difficult subject materials. If I am successful in doing that at this level, then the students will continue to strive for this kind of learning as they progress through the program.

Target student group: Sophomore/Junior. Duration of intervention: Either fall or spring semester.

Brief Description of Institutional/Departmental (Non-anecdotal) Evidence of Strategy’s Effectiveness:

Effectiveness: I implemented this strategy in Spring of 2011 and 2012 and compared my approach with the data when I did not utilize this strategy, in Spring of 2009 and Fall of 2010. First, I looked at how students reacted to course evaluation questions. I specifically looked at three questions, which should show how students are taking the short quizzes. Overall, students’ responses were more positive than before the short quizzes were implemented. Specifically, students get faster and more frequent feedback that reinforced their learning. The class grades were also compared in those four semesters and there was a stark difference. Students’ grades were up and fewer students were failing the course. The following table shows the relevant data.
Quality Education for Minorities (QEM) Network  
Effective Institutional STEM Instructional Strategies at HBCU-UP Grantee Institutions

Institution: Winston-Salem State University Team 1 Cont’d

<table>
<thead>
<tr>
<th>Questions from Course Evaluation Survey</th>
<th>Spring 2011 and Spring 2012 (average)</th>
<th>Spring 2009 and Fall 2010 (average)</th>
</tr>
</thead>
<tbody>
<tr>
<td>Gave quizzes, tests, projects, and assignments that reflected the objectives of the course.</td>
<td>4.93</td>
<td>4.69</td>
</tr>
<tr>
<td>Provided students with useful feedback on tests, reports, projects, and assignments.</td>
<td>4.85</td>
<td>4.34</td>
</tr>
<tr>
<td>Throughout the semester, provided students with feedback regarding their academic performance in the course.</td>
<td>4.83</td>
<td>4.55</td>
</tr>
</tbody>
</table>

<table>
<thead>
<tr>
<th>Average Student Grade</th>
<th></th>
</tr>
</thead>
<tbody>
<tr>
<td>A</td>
<td>37.5%</td>
</tr>
<tr>
<td>B</td>
<td>23%</td>
</tr>
<tr>
<td>C</td>
<td>23.5%</td>
</tr>
<tr>
<td>Less than C</td>
<td>16%</td>
</tr>
</tbody>
</table>

<p>| | |</p>
<table>
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<tr>
<th></th>
<th></th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td>26%</td>
</tr>
<tr>
<td></td>
<td>21.5%</td>
</tr>
<tr>
<td></td>
<td>25.5%</td>
</tr>
<tr>
<td></td>
<td>27%</td>
</tr>
</tbody>
</table>
Peer-Led /Teacher Preparation-focused Strand
Quality Education for Minorities (QEM) Network  
Effective Institutional STEM Instructional Strategies at HBCU-UP Grantee Institutions

Institution: Alabama A&M University Team 2

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Brief Description of STEM Instructional Strategy - In addition to a brief description of the strategy, include discipline; course; target student group (classification); and duration of intervention (summer, fall semester, spring semester, full academic year).

Alabama A&M University has developed an institution-wide collaborative-learning approach to instruction based on the Supplemental Instruction (SI) model in STEM gate-keeping courses. Emphasis has been placed on problem solving, active learning, and inquisition to promote students’ motivation and critical and complex thinking to ensure their deep understanding of content knowledge. The model utilizes tutors or SI leaders to help students integrate course content and learning strategies in regularly scheduled sessions facilitated by trained peer leaders. The Office of Retention and Academic Support (ORAS) in partnership with STEM instructors offers SI program.

Brief Description of Institutional/Departmental (Non-anecdotal) Evidence of Strategy’s Effectiveness:

Our results indicate that the SI strategy is effective in enhancing student performance in introductory STEM courses. This three-year study includes a pool of approximately 750 students in 15 introductory mathematics, physics, chemistry, and engineering courses. Students who participated in the SI tutorial program had an average improvement of one letter grade higher than non-participants. The rate of students receiving an A, B, or C increased by nearly 15% in all of the courses that implemented supplemental instruction. The courses implementing SI also showed a significant reduction in the D, F, and W rates as well (dropping by at least 20%). The significant results of supplemental instruction with dramatic drops in underachievement being replaced by higher levels of success in these gateway courses means that students are persisting in their majors.
Quality Education for Minorities (QEM) Network
Effective Institutional STEM Instructional Strategies at HBCU-UP Grantee Institutions

Institution: Bowie State University Team 1

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**Brief Description of STEM Instructional Strategy:** In addition to a brief description of the strategy, include discipline; course; target student group (classification); and duration of intervention (summer, fall semester, spring semester, full academic year).

A series of modular instructional workshops that incorporates the use of technology with the various teaching modalities for pre-service and current teachers at the elementary and middle school levels to enhance science instruction of K-8 students. These modules are to be collaboratively developed by the Departments of Computer Science and Education. Along with the modular series that should cover the entire academic year, six workshops will be developed for K-8 school administrators, indoctrinating them on the importance of science education at the elementary and middle school levels. These workshops will also be collaboratively developed between the two departments and run fall, summer and spring semesters.

**Brief Description of Institutional/Departmental (Non-anecdotal) Evidence of Strategy’s Effectiveness:**

Pre-service teachers will incorporate these strategies within their year-long internships at the elementary and/or middle school sites. They will be asked to conduct action research based on the use of these strategies to assess the academic achievement of the students. K-12 student assessments also will be measured by achievement on the Maryland School Assessment tests. Current elementary and middle school teachers will be asked to conduct pre- and post-test assessments, as well as complete surveys and questionnaires developed jointly by the two University Departments.

Evaluation Methods: Qualitative and Quantitative evaluative measures will be used to assess the effectiveness of the research, i.e., surveys, questionnaires, outcome of student achievement on Maryland State Assessments, and quality of teacher instruction as measured by teacher evaluations and observations, pre-service teacher instruction as measured by observations and evaluations, as well as science and technology lesson plans and activities depicted in their electronic portfolios, etc.
Quality Education for Minorities (QEM) Network
Effective Institutional STEM Instructional Strategies at HBCU-UP Grantee Institutions

Institution: Bowie State University Team 2

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Brief Description of STEM Instructional Strategy- In addition to a brief description of the strategy, include discipline; course; target student group (classification); and duration of intervention (summer; fall semester, spring semester, full academic year).

Bowie State University was one of six schools to receive a NASA/NSF Model Institution of Excellence (MIE) Award. Through MIE and other previously funded NSF projects, such as the Laboratory for Virtual and Augmented Reality for Research and Education Initiative as well as other projects the STEM Departments have established an infrastructure that supports the Computer Science Departments’ educational and research activities. Easy access to faculty, role models, peer mentors and learning teams, improved curricula, and faculty mentors with whom they can work on research projects are some of the factors that have created an environment that invites students to engage in learning by emphasizing collaborative, interdisciplinary, and inquiry-based experiences. Our target groups are in Computer Science, Computer Technology, and Secondary Education majors for Science and Mathematics. The objectives of our proposed program are:

Objective # 1: Include Peer-to-peer Tutoring
Peer-to-peer tutoring worked very well in the MIE model. We would like to revisit the peer-to-peer tutoring model and include it in all the gatekeeper courses in STEM. They also will mentor the peer tutors and develop an online bank of resources for these gatekeeper courses. The Secondary Education majors for Science and Mathematics will assist in the implementation of problem-based and inquiry-based approaches to peer-to-peer tutoring.

Objective # 2: Infusing Technology into Teaching and Research
We are developing an “Online Student Testing Center” that will allow students to take homework, quizzes and exams from any discipline, and with immediate feedback. This center will operate flexible hours and be accessible from the internet. It will deliver automated feedback on performance for students in courses, pointing to strengths and weaknesses, and showing their progress towards degree.

Objective # 3: To Integrate Research into Curriculum
The design of our proposed program operates on the proven thesis that the scope, depth, and quality of undergraduate training and participation of students in undergraduate research have a strong bearing on the desire and ability of undergraduate students to attend and to succeed in graduate studies. We will promote Hands-on Experience-based projects in class to promote research into curriculum. These projects will focus on a problem-based learning approach to enhance student learning.
Two evaluation strategies will be pursued: formative and summative. Formative evaluation addresses issues concerning the impact of the research on faculty, students, and the institution as the project unfolds. It tends to be internally oriented. Summative evaluation is concerned with issues involving the assessment of the overall project’s impact and effectiveness. It takes on a more external orientation. To insure that the proposed effort stays on track and successfully achieves its goals, several information sources will be utilized including measures of student knowledge gains, attitudes concerning learning experiences, and other output measures such as number of students enrolled interested in graduate school and drop-out rates.

**Brief Description of Institutional/Departmental (Non-anecdotal) Evidence of Strategy’s Effectiveness:**

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. Bowie State University is committed to quality education, offers a comprehensive set of undergraduate and graduate programs and serves over five thousand students. The majority of the students (89%) are African-Americans. The university is fully accredited by the Middle States Association of Colleges and Schools and the Maryland State Department of Education. BSU is part of University System of Maryland (USM) Institutional objectives in the STEM area have been very clearly delineated by the current administration. The objectives include but are not limited to ‘increasing retention rate,’ ‘reducing the time to degree,’ ‘infusing technology into the curriculum,’ ‘redesigning of all gate keeper courses,’ and ‘enhancing the STEM Education.’

The Department of Computer Science offers two BS degree programs: one in Computer Science accredited by ABET, and another in Computer Technology (with a combined enrollment of about 250). The department also offers an MS program (with over 25 graduates) in Computer Science and has about 30 students in a doctoral degree program in Computer Science.

Bowie State was the first university in the country to independently host NASA spacecraft flight operations, and this unique program allows students to take part in all aspects of command and control. To date, more than 150 mission controller certificates have been awarded to Bowie State’s BSOCC students. The program has been featured several times on Public Television and Washington, DC area television channels.
Quality Education for Minorities (QEM) Network
Effective Institutional STEM Instructional Strategies at HBCU-UP Grantee Institutions

Institution: Clark Atlanta University

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Conrad Ingram
Associate Professor
Department of Chemistry
Phone: 404/880-6898   Email: cingram@cau.edu

Brief Description of STEM Instructional Strategy- In addition to a brief description of the strategy, include discipline; course; target student group (classification); and duration of intervention (summer; fall semester; spring semester; full academic year).

This STEM instructional strategy is designed to increase MATH competencies of incoming freshman in order to implement MATH or SCIENCE minor endorsements for interested underclassmen. The courses designed to strengthen math competencies include EDEC 199, which addresses incoming freshmen baseline math skills, and EDEC 211, which address all disciplines and allows students to experience STEM curriculum while advancing in the school of education. By creating Math and Science minors and/or endorsements, all departments are aligning with University and department goals to: (1) strengthen STEM; and (2) address the recruitment and retention initiatives charged by the university. The Math and Science minors and endorsements are in the planning stages and the expectation is to raise math/science competencies while providing more attractive major opportunities for STEM candidates interested in teaching along with research and STEM careers.

The duration of the intervention or the initiative would be a two-year adjustment following the students’ core studies. The discipline would include those math/science courses closely related to high school curriculum. The target group would be rising sophomores at the earliest following the university protocols and acceptance of the proposal.

Brief Description of Institutional/Departmental (Non-anecdotal) Evidence of Strategy’s Effectiveness:

The evidence of the strategy is strictly based on attendance of interested candidates to School of Education interest meetings sponsored by department professors. Students were invited to the School of Education and encouraged to bring a friend to record the interest of potential STEM students in partnering with the SOE to research the possibility of creating a minor and an endorsement in math and science. The topic is on the table at curriculum staff meetings and the documentation has been initiated to create STEM endorsement and minors as well. The strategy has gained considerable momentum as a possible minor or an instructional endorsement.
Quality Education for Minorities (QEM) Network
Effective Institutional STEM Instructional Strategies at HBCU-UP Grantee Institutions

Institution: Elizabeth City State University

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**Brief Description of STEM Instructional Strategy:** In addition to a brief description of the strategy, include discipline; course; target student group (classification); and duration of intervention (summer, fall semester, spring semester, full academic year).

**One of the effective strategies utilized in the currently funded HBCU-UP Implementation award at Elizabeth City State University (ECSU) is peer mentoring. This is a strategy that was proven to be effective in other STEM initiatives at ECSU and therefore was adopted by the HBCU-UP initiative.** This strategy is being used in first-year chemistry, mathematics, physics and computer science courses. Peer mentors are selected from among sophomore students who participated in the VESTEM (Vikings Enhancing STEM HBCU-UP Program) Summer Bridge Program that is specifically targeted for students majoring in chemistry, mathematics, physics and computer science.

During the first year of implementation, the HBCU-UP project mentors were selected from participants in the LSAMP (Louis Stokes Alliance for Minority Participation) program, which has been on the campus for more than 15 years. The peer mentors participate for three years in the program (sophomore, junior and senior year). They attend targeted STEM classes, assist in dormitory after-hour activities and provide updates to the staff. This strategy is utilized in the summer during the Summer Bridge Program as well as the academic year.

**Brief Description of Institutional/Departmental (Non-anecdotal) Evidence of Strategy’s Effectiveness:**

The HBCU-UP VESTEM strategy was implemented during the summer of 2012. This project received funding in Fall 2011 and therefore there are no long-term results to provide at this time. The project, however, contracted an external evaluator to assess the strategy that has been outlined above. The initial results indicated that students were able to build scholarship competencies necessary for a successful first year in college. All participants (11) passed the two summer courses (Math and English) with a letter grade of B or better. In general, students performed better in the math course than the English course. For example, 9 students received a letter grade of “A” and one student transferred high school credit for the pre-calculus course. There was little variation of grades based on major and SAT test scores and GPA. We are currently in the process of collecting student data on academic performance during the first cohort’s progression throughout this academic year. This cohort is enrolled in English as a group and also many of them are enrolled in the same math course.
Quality Education for Minorities (QEM) Network
Effective Institutional STEM Instructional Strategies at HBCU-UP Grantee Institutions

Institution: Howard University

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**Brief Description of STEM Instructional Strategy** - In addition to a brief description of the strategy, include discipline; course; target student group (classification); and duration of intervention (summer; fall semester; spring semester; full academic year).

The intervention model of group peer tutoring is used in some of the introductory calculus-based Physics courses at Howard University to assist and improve the academic performance of students. Group peer tutoring is a strategy that benefits both the students who prepare to tutor another student and the tutored student. When a student being tutored doesn’t get a clear understanding of a concept or problem, the tutor provides further explanation or clarification. The tutor explains the concepts that the student missed in a new way. This has proven to be an effective technique for increasing students’ academic achievement. For peer tutoring in a group setting, all members of the group participate as tutors. It appears that the success of peer tutoring in the introductory physics courses depends on the social interaction and bonds between the tutors and the tutees. The informal relationship between the tutors and tutees may provide a less stressful learning environment than a traditional lecture or even faculty office hours.

The group peer tutoring approach has resulted in a significant gain in students’ performance in the Howard University introductory physics courses. Students would come as a large group to sessions held regularly from 5-7pm in the physics building. Students in the group would ask about homework questions after having previously reviewed the material. Some of the students who may have been helped at an earlier time with the homework are then asked to explain the solution to the best of their ability to the rest of the group. When there are incorrect explanations or incomplete explanations, an instructor or advanced student would then step in and help.

Peer tutoring presents an invaluable opportunity for student to gain transferable skills such as communication, planning and organization. Since the implementation of the peer tutoring intervention, improvement in terms of academic performance has increased. Peer tutoring has been shown to be an integral part of an effective way for students to learn physics and has helped to increase students’ motivation and interest in physics.

**Brief Description of Institutional/Departmental (Non-anecdotal) Evidence of Strategy’s Effectiveness:**

Anecdotal evidence from the introductory physics class suggests that peer tutoring is an important tool used to increase learning in physics.
Quality Education for Minorities (QEM) Network
Effective Institutional STEM Instructional Strategies at HBCU-UP Grantee Institutions

Institution: Howard University, Submission 2

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Brief Description of STEM Instructional Strategy- In addition to a brief description of the strategy, include discipline; course; target student group (classification); and duration of intervention (summer, fall semester, spring semester, full academic year).

Using Models, Analogies and Discussions to Facilitate Students’ Thinking and Learning Science
Secondary Science Methods: Pre-service and in-service teachers
Fall Semester

Students often find it easier to grasp a new concept if they can visualize it in the form of a model or analogy. Asking students to supply analogies is an excellent way to determine whether students have an adequate understanding of the concept being presented. Using models and analogies can stimulate students’ interest in learning science. Engaging pre-service and in-service teachers in this method of active learning through scientific inquiry encourage them to observe, ask questions, collect and interpret data. They can use this type of pedagogical techniques with students in their own classrooms.

Brief Description of Institutional/Departmental (Non-anecdotal) Evidence of Strategy’s Effectiveness:

Since some students lack the background to learn difficult concepts in biology, chemistry and physics using analogies is an effective way to deal with this problem. Using analogies allow new materials, especially abstract concepts, to be more easily assimilated with student’s prior knowledge, enabling them to develop a more scientific understanding of the concept. Analogies help student learning by providing visualization of abstract concepts, by helping compare similarities of the students’ real world with the new concepts. Three data sources were utilized during this study: 1) in-class observation (notes, diagrams etc.), 2) teacher interviews after the lessons, and 3) student interviews after the lessons.
Quality Education for Minorities (QEM) Network  
Effective Institutional STEM Instructional Strategies at HBCU-UP Grantee Institutions

Institution: Langston University Team 2

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**Brief Description of STEM Instructional Strategy**- In addition to a brief description of the strategy, include discipline; course; target student group (classification); and duration of intervention (summer, fall semester, spring semester, full academic year).

The Mathematics Department and the School of Education hope to conduct a two-week summer bridge STEM program for STEM Education Majors. Our target cohort group will be high school graduates who have accepted to Langston University. Information from the cohort will be disseminated in the form of a final report along with surveys from each of the participants for each cohort group. We will continue to follow-up with these students throughout the academic year by having small monthly focus group meetings to monitor their progress. We will use an online software package that will allow us to monitor their progress in math and science. Students will receive stipends for the summer bridge component as well as scholarships for each semester of the first year. The Cohort model is a response to increase students becoming a STEM certified and licensed teachers.

**Brief Description of Institutional/Departmental (Non-anecdotal) Evidence of Strategy’s Effectiveness:**

The research question is, “What are the factors that determine whether a student will choose a STEM teaching career?” Mixed methods research will be used to determine dispositions, the high school graduates’ ACT and/or SAT scores, secondary STEM grades and practice OGET teacher test data. The accepted high school graduates will be spending two weeks at the Langston University main campus. Cohort students will participate in mock STEM teaching, electronic portfolio, technology use, and test-taking skills in which qualitative and quantitative data will be collected for analyses. Cohort students will enroll in the following fall and spring semesters as STEM education majors. Cohort STEM students will receive STEM funds and curriculum and instruction strategy opportunities that promote classroom
Quality Education for Minorities (QEM) Network
Effective Institutional STEM Instructional Strategies at HBCU-UP Grantee Institutions

Institution: Langston University Team 2 Cont’d

Teaching, learning, and teacher certification. Long-term quantitative data from Oklahoma STEM education majors’ certification tests—the Oklahoma General Education Test (OGET), which tests reading, mathematics, and science; Oklahoma Subject Area Tests (OSAT), which test STEM subject matter; and the Oklahoma Professional Teacher Examination (OPTE), which tests professional teaching curriculum—will be analyzed. The site coordinator, STEM faculty, LUSOEBS and Arts and Sciences faculty will be Academy and Cohort STEM mentors throughout the project.

Intellectual Merit: The Teacher Bridge Cohorts for STEM education majors will help to understand what factors influence students to choose STEM education. A Teacher Bridge Cohort of female and male STEM teaching experiences may increase the number of STEM teachers. Students in the Teacher Bridge Cohort will be able to enhance their STEM knowledge, skills, and professional dispositions from new teaching perspectives.

Broader Impacts: The proposed project effects will help to increase female and male STEM trained certified and licensed teachers, especially teacher diversity through Teacher Bridge Cohorts of high school graduates. Secondary students will be able to engage with female and male STEM teachers. LU STEM pre-service teachers will gain advanced STEM teacher education training for secondary schools.
Quality Education for Minorities (QEM) Network
Effective Institutional STEM Instructional Strategies at HBCU-UP Grantee Institutions

Institution: Morehouse College

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<th>Brief Description of STEM Instructional Strategy: In addition to a brief description of the strategy, include discipline; course; target student group (classification); and duration of intervention (summer, fall semester, spring semester, full academic year).</th>
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<td><strong>Peer-Led Team Learning (PLTL), all STEM courses, all STEM students, full academic year</strong></td>
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<td>Identifying strong students and providing them with opportunities to guide instruction sessions inside and outside course.</td>
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<th>Brief Description of Institutional/Departmental (Non-anecdotal) Evidence of Strategy’s Effectiveness:</th>
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<td>Improved student performance on assignments and tests. Positive student feedback on improved comprehension of course content through course surveys and in-class discussions.</td>
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Quality Education for Minorities (QEM) Network
Effective Institutional STEM Instructional Strategies at HBCU-UP Grantee Institutions

Institution: Southern University at Baton Rouge Team 1

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Brief Description of STEM Instructional Strategy- In addition to a brief description of the strategy, include discipline; course; target student group (classification); and duration of intervention (summer, fall semester, spring semester, full academic year).

Quality Matters (QM) is a faculty-centered, peer review process that is designed to certify the quality of online and blended courses. It provides quality assurance for online education. There are three primary components in the QM Program: the QM Rubric, the Peer Review Process, and QM Professional Development. **We have applied the QM standards in designing quality online courses for undergraduate STEM disciplines (e.g. Computer Science) and the Ph.D. program in Science/Math Education (SMED).** Minority students in STEM fields use these courses. We have provided faculty development training from 2009-2011 to more than 120 faculty members at Southern University in Baton Rouge and SUNO (Southern University at New Orleans) to develop courses aligned to the QM standards. Courses developed are being deployed at institutions. We are engaging graduate students in the SMED program to develop assessment and evaluation instruments to measure learning gains and online students learning outcomes. This research will result in doctoral dissertations and publications for dissemination.

Brief Description of Institutional/Departmental (Non-anecdotal) Evidence of Strategy’s Effectiveness:

The QM standards are currently used campus-wide for developing online courses and faculty are required to complete a certification course provided through Professor Diack (Official QM trainer) before they can deliver a course online. These are nationally recognized standards aligned with the Southern Association of Colleges and Schools (SACS) Accreditation requirement for online degree programs. Qualitative studies are being conducted by graduate students to measure effectiveness in improving online students learning outcomes. These studies are part of doctoral dissertations at SUBR. Through this strategy, students get active involvement in learning, problem solving, and clarification of the purposes of learning. This improves outcomes for graduates by providing students with competitive edge in the workforce and enhances the institutional enterprise by integrating QM learning.
Institution: Tougaloo College

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Brief Description of STEM Instructional Strategy—In addition to a brief description of the strategy, include discipline; course; target student group (classification); and duration of intervention (summer, fall semester, spring semester, full academic year).

Increase student understanding of fundamental Physics concepts and develop expert-like problem solving skills among STEM majors taking trigonometry-based and calculus-based introductory physics courses, by utilizing tools developed by the Physics Education Research community, incorporating appropriate pre- and post-test (Force Concept Inventory and Mechanics Baseline test) for assessment, and developing a detailed check list for monitoring progress in understanding individual concepts, along with in-house development of pedagogical skills in collaboration with the Education Division. These required courses are subscribed by the STEM students mostly in the Sophomore/Junior year. The college courses last the entire academic year, but the portable strategies developed here can easily be modified for teacher training for high school or college instructors, and for students in high-school to college Physics bridge programs.

Brief Description of Institutional/Departmental (Non-anecdotal) Evidence of Strategy’s Effectiveness:

Some aspects of the above mentioned strategies have been implemented in the Introduction to Physics course (Trigonometry-based) and showed success through substantial increase between the pre- and post-test scores for the FCI, increase in rates of students passing with a grade of C or higher, and increase in the percent of students passing the course with A.
Quality Education for Minorities (QEM) Network
Effective Institutional STEM Instructional Strategies at HBCU-UP Grantee Institutions

Institution: Virginia State University Team 1

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**Brief Description of STEM Instructional Strategy** - In addition to a brief description of the strategy, include discipline; course; target student group (classification); and duration of intervention (summer, fall semester, spring semester, full academic year).

One of the objectives of the STEM Instructional Strategy at VSU is to integrate theory and content in the areas of reading, science, and pedagogy by developing coordinated projects across methods courses in elementary education. **Building on the Akerson and Flanigan model, the three instructors at VSU teaching the elementary education pedagogy, language arts, and sciences methods courses are collaborating on instructions towards these common goals to prepare preservice teachers to:**

- **Use multiple instructional strategies**, such as Five E’s “Engage, Explore, Explain, Elaborate, and Evaluate” and problem-based/place-based inquiry learning; and
- **Develop strategies to assess science and language arts learning in elementary students using multiple modes of assessment.**

This collaboration includes team teaching, coordination of field-based experiences, and scheduling of courses in adjoining block schedules to facilitate overlapping class projects. A statistician will work closely with the team to ensure that data collection and data management are properly done. This collaboration enhances, but does not replace, the pedagogical training, general literacy skills and hands-on science instruction of the individual methods courses. It is hypothesized that using an interdisciplinary approach, the goals and objectives of all three methods courses will be met and make the elementary education curriculum more science-intensive.

Target Student Group (classification): Junior and Senior elementary education preservice teachers.
Duration of Intervention: 2 years

The content of the methods courses will continue to be in compliance with all state-approved curriculum plans; however, instructional delivery of the methods courses will be modified. In short, we seek to change the way science is taught.

**Brief Description of Institutional/Departmental (Non-anecdotal) Evidence of Strategy’s Effectiveness:**

We started this intervention in the Fall 2012. Preliminary data, including pre-Science Teaching Efficacy Belief Instrument (STEBI-B) and inquiry-based lesson plans developed by the target student group, will be compared with post-assessments at the completion of the three methods courses.
Quality Education for Minorities (QEM) Network
Effective Institutional STEM Instructional Strategies at HBCU-UP Grantee Institutions

Institution: Xavier University of Louisiana

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Brief Description of STEM Instructional Strategy- In addition to a brief description of the strategy, include discipline; course; target student group (classification); and duration of intervention (summer; fall semester, spring semester, full academic year).

The Mathematics Department of Xavier University will devise a year-long version of its college entry-level Pre-calculus course to be offered at a cooperative high school in New Orleans. The course will have detailed learning objectives and lesson plans and will be conducted two days a week by a college professor. The lead high school teacher will serve as an adjunct teaching assistant the other three days per week working with the students in small groups to make sure that all coursework is well understood and learned. The college professor will prepare, grade and administer all tests and the final examination. Students will be given college credit upon successful completion of the course. No college record will be made for students who are unsuccessful. Xavier’s Division of Education will offer students in its undergraduate Special Methods class the opportunity to serve as undergraduate teaching assistants and observe, discuss and write about the teaching methods. The Division will also offer a graduate course in Special Methods for teachers to observe, discuss and write about the teaching methods of the course and high school curriculum ramifications of this course as the exit course for high school.

Brief Description of Institutional/Departmental (Non-anecdotal) Evidence of Strategy’s Effectiveness:

Xavier has had a successful concurrent college admissions program on its campus for a long time. However, the disruption from the Hurricane Katrina disaster had made it very difficult for students to travel to XU’s campus to take college credit courses while still enrolled in high school. The strategy outlined above will have the added benefit of educating the mathematics teacher(s) in the high school about what is really expected of their students.
Student-centered Strand
Quality Education for Minorities (QEM) Network
Effective Institutional STEM Instructional Strategies at HBCU-UP Grantee Institutions

Institution: Alabama A&M University Team 1

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Brief Description of STEM Instructional Strategy-
In addition to a brief description of the strategy, include discipline; course; target student group (classification); and duration of intervention (summer, fall semester, spring semester, full academic year).

A highly effective avenue to recruit, retain, and prepare Science and Engineering students for careers in STEM fields is the undergraduate research experience. Since summer of 2007 the Department of Physics at Alabama A&M University, has offered the Research Experience for Undergraduate (REU) program. Each summer, eight participating students with a diverse demographic breakdown, spent ten weeks working exclusively on research as an apprentice to a faculty scholar. Targeted groups were mostly rising junior and rising senior underrepresented students from institutions with limited research facilities.

Brief Description of Institutional/Departmental (Non-anecdotal) Evidence of Strategy’s Effectiveness:

Our qualitative findings of a six-year REU program in physics, revealed a positive impact of undergraduate research program on minority student retention, academic achievement, and professional development. Participants reported the general taxonomy of benefits including substantial gains on self-confidence, independence, intellectual skills, research design, data acquisition and analysis, written and communication skills and teamwork. Other essential learning outcomes that emerged from the REU initiative were students’ learning of how knowledge is constructed, their understanding of how scientists think, as well as a sense of accomplishment through scholarly publication. Yet another positive effect was the pursuit of post-graduate STEM education of all participants. This program is evaluated by keeping track of the REU participants joining/considering joining AAMU for further studies, staying in STEM disciplines at their home institutions, or joining graduate programs in STEM disciplines. Assessment of the program also uses exit surveys, student technical publications and presentations at national and international conferences, and continuation of their career in STEM disciplines.
Quality Education for Minorities (QEM) Network  
Effective Institutional STEM Instructional Strategies at HBCU-UP Grantee Institutions

Institution: Dillard University Team 1

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**Brief Description of STEM Instructional Strategy:** In addition to a brief description of the strategy, include discipline; course; target student group (classification); and duration of intervention (summer, fall semester, spring semester, full academic year).

The course is Biology 101, the target population is non-majors, and group number/classification is 140 freshman students per semester. It has been discovered that non-majors have a difficult time in Biology, therefore I ask to make my class part of the University’s Supplemental Instruction (SI) program. SI is an academic support program designed to improve the students’ academic success and increase retention. SI sessions are led by their peers who successfully completed the course. SI is a series of weekly review or study sessions for students enrolled in Biology 101. SI is provided to students who want to improve their understanding of course material and improve their grades. SI is not a substitute for class, doing assigned homework or meeting with the course instructor. SI leaders attend and participate in classes along with students, then design and lead study session based on the lecture. SI leaders explain scientific processes, mathematical equations, and help students grasp challenging topics. In SI session, students will be able to clarify lecture notes, review assigned readings, discuss key course concepts, and receive study tips.

Faculty members are not responsible for training or supervising SI Leaders or for enforcing student participation, which is strictly voluntary; however, faculty support is vital to the success of the program. The payoff is increased class attendance and participation, as well as higher pass rate. To enhance and facilitate the SI program, faculty members are encouraged to:

- Allow the SI Leader to make weekly announcements and send e-mails
- Post-SI session schedules in classroom, on syllabus and on WebCT
- Provide the SI Leader in advance with all course supplements and study materials
- Meet with the SI Leader to review session materials and discuss class content
- Provide student data to the SI Office to evaluate the effectiveness of the SI Program

**Brief Description of Institutional/Departmental (Non-anecdotal) Evidence of Strategy’s Effectiveness:**

This is the first time the Biology 101 non-majors course has been exposed to Supplemental Instruction. In an oral survey with the students, the following positive comments were made:

- Work in small, collaborative groups with your classmates.
- Review lecture material, course reading, and homework.
- Go over exam strategies with SI leaders who know the course and professors.
Quality Education for Minorities (QEM) Network
Effective Institutional STEM Instructional Strategies at HBCU-UP Grantee Institutions

Institution: Dillard University Team 1 Cont’d

- Attend as often as you like.

At mid-term, grades were much higher.

Each year, the Dillard Biology Department graduates compete for entry into nationally-rated graduate and professional programs. We are proud of our successes and have a vision that all graduating Biology majors will be actively recruited by graduate and professional programs. Departmental faculty members engage students in environmental biology and molecular biology research projects.

Students are encouraged to participate in summer research experiences with either faculty on campus or with mentors around the country. For both instructional purposes and research projects the School of STEM has established a Molecular Biology Core Laboratory and an Interdisciplinary Environmental Sciences Research Laboratory. The Biology Department and the School of STEM has established collaborations and articulation agreements that provide opportunities for biology majors to conduct research in laboratories at research-intensive institutions (The Leadership Alliance, University of Colorado at Boulder, University of South Alabama, etc.). The funding of the Urban Interdisciplinary Environmental Studies Initiative has resulted in the establishment of an Environmental Studies concentration. The Division has also established agreements for dual degree programs. Relevant to biology majors are the combined BS and health professional degrees in dentistry, medicine or podiatric medicine (Meharry Medical College, Boston University, Ohio College of Podiatric Medicine, etc.). All Biology Department faculty members actively seek additional grant funding (Dillard University Presidential and Mini Awards, Louisiana Board of Regents Special Fund, American Society for Cell Biology, the National Science Foundation, etc.) to support their research projects.
Quality Education for Minorities (QEM) Network  
Effective Institutional STEM Instructional Strategies at HBCU-UP Grantee Institutions

Institution: Fisk University

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Brief Description of STEM Instructional Strategy- In addition to a brief description of the strategy, include discipline; course; target student group (classification); and duration of intervention (summer; fall semester, spring semester, full academic year).

“Concept and Application Mastery in Developmental Biology through a Blended Learning Model.” The target student group will be upper level undergraduates (primarily seniors with a few juniors). This course will be offered Spring Semester 2013, but progress will be tracked and course design will be adjusted accordingly throughout subsequent semesters. The learning objectives are: (1) significantly increase student understanding of 10 essential concepts in developmental biology; (2) significantly increase student ability to apply concepts across multiple organisms and in multiple fields of study; and (3) significantly increase student ability to analyze and interpret data from the scientific literature. The activities included as part of this strategy are online quizzes, supplemental videos and tutorials, online reading assignments with rubric-guided discussion forums, and a collaborative online portfolio. Among the motivating factors for these methods is the knowledge that many concepts in developmental biology can be reinforced through experiencing multiple examples from several different organisms rather than a single exemplar, allowing students to grasp the commonalities (and differences) between organisms. A blended strategy offers students the chance to view and interact with a larger range of material. At least one practice and one graded online quiz for each of the ten essential concepts will be posted to our course website, with the option for students to retake the practice quiz as many times as desired to self-assess “mastery.” This class will be offered as a joint undergraduate and graduate course, and as part of the graduate course, the few Master’s students in the course will serve as moderators for the discussion forums, encouraging discussion and providing a summary of discussion points after each assigned discussion forum.

Brief Description of Institutional/Departmental (Non-anecdotal) Evidence of Strategy’s Effectiveness:

Assessment instruments for student achievement will include an identical pre-test/post-test administered both on the first day of class and as a final exam. Quizzes for each of the 10 concepts will assess student mastery in a formative (as the class as a whole progresses) and summative (for each individual concept) manner. Discussion assignments and other online activities will be measured by rubrics assessing the students’ ability to apply concepts across multiple organisms and fields and interpret data from the scientific literature. The instructional strategy/program success will be evaluated in several ways. Data will be collected regarding how frequently students took advantage of the online resources. How often did students avail themselves of online resources? Is there a correlation between practice quiz attempts
and degree of mastery? The students will be surveyed about which strategies were the most helpful in achieving the learning objectives. A final portfolio will include the students’ perspectives and reflections on the effectiveness of the components. An implementation evaluation will include an analysis of whether all proposed elements were integrated into the course smoothly and list any challenges or unexpected results.
Quality Education for Minorities (QEM) Network
Effective Institutional STEM Instructional Strategies at HBCU-UP Grantee Institutions

Institution: Fort Valley State University

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**Brief Description of STEM Instructional Strategy:** In addition to a brief description of the strategy, include discipline; course; target student group (classification); and duration of intervention (summer, fall semester, spring semester, full academic year).

**STEM instructional strategy described here aims at the strengthening of entomology course taught in the Department Biology, Fort Valley State University by providing more instructional and laboratory facilities for insect chemical ecology, insect pathology and forensic Entomology program.** We are focusing on chemical ecology, insect pathology and forensic entomology because these are emerging technologies within entomology that bring with them certain important and basic STEM skills that are needed in microbiology, mathematics, biochemistry and chemistry. This will be introduced via three objectives: (1) enriching the academic preparations of Entomology students by developing course reforms that include laboratory experiences; (2) enhancing quality research experiences for Entomology students at FVSU that help students get accepted into graduate programs; and (3) instituting activities that arm students with the skills they need to secure employment in pest control industry or as forensic laboratories. We feel this is a holistic approach that integrates classroom instructions, laboratory experiences and investigative approach.

**Brief Description of Institutional/Departmental (Non-anecdotal) Evidence of Strategy’s Effectiveness:**

In the short run, our strategy is working, as students who participate in the project outscore students who do not participate in most Biology and Chemistry courses. More graduating students of FVSU that participated in the project are advancing to graduate programs in Entomology or other sciences. Some are securing jobs as laboratory assistants or as teachers. In about ten years from now, we anticipate that more of the program alumni will earn doctorates in various science disciplines.

Assessment/Evaluation: Tests will be administered to students at the beginning, at midterm and at the end of each course period. The tests will contain such questions that will provide information on the knowledge of entomology facts by participating students at the three stages of project evaluation. Students’ experience in laboratory will be evaluated by finding out whether students feel that the newly
installed laboratory facilities and learning aids have improved their learning of Entomology especially by demonstrating special and new skills. The test will assess whether students’ interest in entomology becomes more intense over time, and whether the proficiency with which students perform acquired IPM skills improves with time. New lecture series and laboratory instructions in entomology will be presented at the annual meeting of the Association for Biology Laboratory Education (ABLE) for critique and evaluation. Long-term evaluation will be to monitor the number of participants that proceed to graduate programs in STEM disciplines.
Quality Education for Minorities (QEM) Network
Effective Institutional STEM Instructional Strategies at HBCU-UP Grantee Institutions

Institution: Lincoln University, Pennsylvania

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Brief Description of STEM Instructional Strategy- In addition to a brief description of the strategy, include discipline; course; target student group (classification); and duration of intervention (summer, fall semester, spring semester, full academic year).

Lincoln University uses the Supplemental Instruction (SI) student learning support program to target STEM courses that have a 30 percent or higher rate of D or F for final course grades and to provide regularly scheduled, out-of-class, peer-facilitated sessions that offer students an opportunity to discuss and process course information. This proposal focuses on Biology. Lincoln’s SI Program is a newly implemented program funded by the NSF for five years as of October 1, 2010. The target student group is freshmen and sophomores who are enrolled in entry-level classes in STEM disciplines. The duration of intervention for Biology is one semester. Lincoln University’s SI Program uses a formative assessment plan designed to track student performance by comparing the SI participants and the non-SI participants to determine the effectiveness of the SI program. An assessment of the SI Program for all classes showed a 21% increase in the passing rate from the Baseline (prior to SI intervention) year, 2009-2010, to the year the program was implemented, 2011-2012. A 17.5% increase in passing rate was also observed from the Pilot year, 2010-2011, to the implementation year, 2011-2012.

Brief Description of Institutional/Departmental (Non-anecdotal) Evidence of Strategy’s Effectiveness:

The table below reflects data that was collected from the Baseline, Pilot and Implementation years of the SI Program for Bio 103.01. Clearly the implementation of the SI program has improved the passing rate of the students in this course. These results reflect the first time the SI Program was implemented at Lincoln University; therefore, trends that truly reflect student performance and the effectiveness of the SI Program will be observed as the program matures.

<table>
<thead>
<tr>
<th>Course Number</th>
<th>Course Name</th>
<th>2009-2010 Baseline Passing Rate</th>
<th>2010-2011 Pilot Year Passing Rate</th>
<th>2011-2012 Year 1 Passing Rate</th>
<th>% Change Pilot-Year 1</th>
</tr>
</thead>
<tbody>
<tr>
<td>BIO-103</td>
<td>GEN BIO I</td>
<td>53.5</td>
<td>62.3</td>
<td>73.20</td>
<td>17.50</td>
</tr>
</tbody>
</table>

47
Institution: Morgan State University Team 1, Submission 1

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**Brief Description of STEM Instructional Strategy**
- In addition to a brief description of the strategy, include discipline; course; target student group (classification); and duration of intervention (summer, fall semester, spring semester, full academic year).

The instructional strategy being described is a Pre-Professional cohort. This cohort currently consists of seven psychology majors who have strong academic records and aim to apply to and attend a STEM doctoral program following graduation. Each student was selected during their freshman and sophomore years and invited to participate by Dr. Hodges. The cohort meets weekly for one hour during the academic year. Within this hour, the students are advised and mentored by Dr. Hodges. Each session, Dr. Hodges leads a discussion on various topics including writing personal statements, requesting letters of recommendations, time management, summer internships and graduate school application requirements. Additionally, students participating in the cohort must complete weekly assignments and attend workshops and fairs sponsored by various university departments and programs that provide information about STEM graduate programs and/or research opportunities.

The program would assess knowledge of and attitudes about STEM internships and graduate programs. Each student would create a portfolio, which would include personal statements, completed applications and other related information.

The program will be evaluated by administering surveys to students that measure graduate school readiness and knowledge in September and May of each academic year. We will also quantify effectiveness by measuring how well the expected outcomes were attained at the end of each academic year. Expected outcomes include student placement in summer STEM research internship, completion of STEM graduate school applications and admittance into STEM graduate programs.

**Brief Description of Institutional/Departmental (Non-anecdotal) Evidence of Strategy’s Effectiveness:**

This instructional strategy has effectively increased the number of psychology majors who are pursuing and engaged in STEM research opportunities. One cohort participant, who was a rising junior, successfully applied to and was accepted into the MBRS-RISE program and began conducting research with a faculty advisor during the summer 2012. Additionally, two rising sophomores, who participated in the cohort, applied to and were accepted into the Summer Program on Mind and Brain at Colorado State University which was funded by the National Science Foundation.
Quality Education for Minorities (QEM) Network
Effective Institutional STEM Instructional Strategies at HBCU-UP Grantee Institutions

Institution: Morgan State University Team 1, Submission 2

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**Brief Description of STEM Instructional Strategy**

In addition to a brief description of the strategy, include discipline; course; target student group (classification); and duration of intervention (summer; fall semester; spring semester; full academic year).

Thinking maps are an instructional strategy implemented during the fall 2012 semester in two sections of the General Psychology (PSYC 101) course. The overall aim of using thinking maps is to encourage the use basic mental processes to perceive, process and evaluating information. By integrating thinking and mapping strategies, students are able to master these skills and display improved writing skills. Students receive instructions from the professor about which thinking map to use and what topic to map.

PSYC 101 is a required course for all psychology majors and also serves as a General Education elective for all students (STEM and non-STEM) at Morgan State University. Psychology majors take this course during the first two years of matriculation and it serves as a prerequisite for all psychology courses. This intervention has been inserted during the lecture period throughout the fall 2012 semester to actively engage students in their learning process.

The goal of this instructional strategy is that the use of the thinking maps will facilitate content learning by students resulting in an increase of passing grades. Therefore, we will assess whether students grades are increasing by collecting data from exams given throughout the semester.

The instructional strategy would be evaluated by having each student complete a general psychology assessment at three points throughout the semester, within the first week, midway through the semester and the last week of the semester. Scores on each assessment would be compared to determine if students increased content knowledge. These scores would be compared to comparable student assessments in sections of General Psychology not using thinking maps.

**Brief Description of Institutional/Departmental (Non-anecdotal) Evidence of Strategy’s Effectiveness:**

The instructional strategy has been effective in improving performance in a STEM course. Students who completed a thinking map prior to the first exam averaged a grade of 72.46% on the first exam. Students who did not complete a thinking map averaged a grade of 65.38% on the same exam.
Quality Education for Minorities (QEM) Network
Effective Institutional STEM Instructional Strategies at HBCU-UP Grantee Institutions

Institution: North Carolina A&T State University Team 2

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**Brief Description of STEM Instructional Strategy:** In addition to a brief description of the strategy, include discipline; course; target student group (classification); and duration of intervention (summer, fall semester, spring semester, full academic year).

**Project-based Learning** has many benefits, which increase levels of student achievement. Hands-on learning, student directed inquiry and research, designing and building models for development of concepts, as well as student-generated scientific discourse are all strategies that lead to high levels of engagement.

**Brief Description of Institutional/Departmental (Non-anecdotal) Evidence of Strategy’s Effectiveness:**

The strategies have been applied to the teaching in computer science course: COMP 690: Social Computing. Through project based learning, we have improved the research capability of the students for future research. One hundred percent (100%) provides the highest score for the course evaluation.

Hands-on learning is being applied to the CS programming course; we will have detailed feedback at the end of semester.
Quality Education for Minorities (QEM) Network
Effective Institutional STEM Instructional Strategies at HBCU-UP Grantee Institutions

Institution: North Carolina A&T State University Team 3

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Brief Description of STEM Instructional Strategy- In addition to a brief description of the strategy, include discipline; course; target student group (classification); and duration of intervention (summer, fall semester, spring semester, full academic year).

The Departments of Mathematics, Chemistry, Biology and Physics at NCA&T are in the process of re-designing twelve key freshmen and sophomore mathematics and science courses (MATH 103, 104, 110 and 131; BIOL 101 & 102; CHEM 106 & 107; PHYS 225, 226, 241 and 251) that will embrace the “up-side-down” model for learning. Students will no longer sit through numerous one-way lectures, but they will be actively engaged in the learning process using technology, collective thought, hands-on work and collaborative communication. This innovative student success project will increase students’ “time on task” that will build confidence, enhance mastery and improve performance. The intervention will be ongoing for the full academic year.

The Mathematics Department will use the Emporium Model which will eliminate lecture and uses commercially available interactive computer software combined with personalized on-demand assistance and mandatory student participation. The underlying principle of the Emporium Model is that students will learn mathematics by doing mathematics, not by listening to someone talk about doing mathematics, while instructors serve as facilitators who guide students.

The Biology Department will use the active learning environment to provide student-centered instruction and inquiry-based learning. The students will meet once a week for two-hour laboratory sessions that will be designed to engage them in collaborative problem-solving using virtual research laboratory activities and case-based studies.

The Chemistry Department will implement the Discovery Learning Method (DLM) modeled after the University of Maryland-Baltimore County’s (UMBC) program that involves inquiry-based learning. Students taking general chemistry at NC A&T will be required to participate in weekly small group discovery learning sessions in the renovated computer labs.

The Physics Department will complement the traditional lecture environment with adopting the studio model as a method for recitation and laboratory instruction (Wilson 1993). The studio format is a student-centered learning method that promotes active learning, and integrates lecture and laboratory work into one activity.
Quality Education for Minorities (QEM) Network
Effective Institutional STEM Instructional Strategies at HBCU-UP Grantee Institutions

Institution: North Carolina A&T State University Team 3 Cont’d

<table>
<thead>
<tr>
<th>Brief Description of Institutional/Departmental (Non-anecdotal) Evidence of Strategy’s Effectiveness:</th>
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<tbody>
<tr>
<td>The effectiveness is yet to be seen as the strategy for each Department is in the implementation stages.</td>
</tr>
</tbody>
</table>
Brief Description of STEM Instructional Strategy- In addition to a brief description of the strategy, include discipline; course; target student group (classification); and duration of intervention (summer; fall semester, spring semester, full academic year).

Engage the students: This is a really important element for lecture courses. Grading: Establish fair and clear grading policies. Set clear goals: Students respond best to goals that are both challenging and achievable. Identify misconceptions early: Once a misconception takes root, it is difficult to remove. Students make mistakes: Students learn more from understanding why an incorrect answer is wrong rather than memorizing the correct answer. Group Help: In various times, Student might comprehend the subject what it is explained by different student that understands the subject.

At Talladega College we try to implement STEM strategies to all of the science and non-science majors. These are implemented in different STEM courses such as chemistry, physics and mathematics. The duration of intervention is the full academic year for the goal of achieving excellence.

Brief Description of Institutional/Departmental (Non-anecdotal) Evidence of Strategy’s Effectiveness:

The strategy implemented at Talladega College showed a lot of progress especially with the freshmen and sophomore student that had trouble with STEM subject. It was noticed firsthand how the student became more acceptable to the STEM courses with increase in student participation and group study which resulted in higher grades and understanding of the subject.
Quality Education for Minorities (QEM) Network  
Effective Institutional STEM Instructional Strategies at HBCU-UP Grantee Institutions

Institution: University of the Virgin Islands

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**Brief Description of STEM Instructional Strategy:** In addition to a brief description of the strategy, include discipline; course; target student group (classification); and duration of intervention (summer, fall semester, spring semester, full academic year).

**The instructional strategy is providing students with training in creative problem solving (CPS).**  
CPS is currently being implemented in Science 100 (SCI 100). SCI 100 is a required, first-year course for all students (STEM and non-STEM) matriculating at the University of the Virgin Islands. The intervention is offered during the fall and spring semesters. Students receive training in CPS and weekly assignments embedded in the curriculum to foster their creative thinking skills. The Torrance Test for Creative Thinking (TTCT) is administered pre/post to measure CPS skills.

**Brief Description of Institutional/Departmental (Non-anecdotal) Evidence of Strategy’s Effectiveness:**

The instructional strategy has been effective in retaining students in the STEM pipeline. Of the STEM students in the experimental group, who have received CPS training, 69% are in good academic standing; 22% are on academic probation/suspension; and 9% are not enrolled at the University.
Quality Education for Minorities (QEM) Network
Effective Institutional STEM Instructional Strategies at HBCU-UP Grantee Institutions

Institution: Winston-Salem State University Team 2

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**Brief Description of STEM Instructional Strategy:** In addition to a brief description of the strategy, include discipline; course; target student group (classification); and duration of intervention (summer, fall semester, spring semester, full academic year).

WSSU-STEM Instructional Strategy: Previous studies have demonstrated the importance of guided-inquiry (GI) as a more effective teaching strategy in promoting students’ learning in STEM disciplines and to enhance student’s critical thinking and problem solving skills. Students who participate in GI-based laboratory experiments typically find GI learning experiences more exciting and hands-on, compared to the traditional “cook book” learning experiment, where students simply follow laboratory manuals.

Consequently, we have currently redesigned General Chemistry I, Organic Chemistry I, Instrumental Analysis, and Quantitative laboratory courses by incorporating the GI-based approach to enhance the basic understanding of chemistry principles and to motivate students in basic research in STEM discipline. To achieve this goal, we incorporated various GI experiments including the determination of Fe content in food items; determination of moisture content of pharmaceutical products; and determination of water quality parameters into Instrumental Analysis and Quantitative Analysis courses. We have also incorporated other exciting GI experiments into General Chemistry I (freshman) and Organic 1 laboratory (junior) courses. The use of GI in chemistry laboratory courses was initiated in the Fall 2008 and GI is continued to be utilized in most chemistry laboratories.

**Brief Description of Institutional/Departmental (Non-anecdotal) Evidence of Strategy’s Effectiveness:**

The result of GI laboratory has proved to be very effective in promoting student learning and success. First, GI-based study has promoted hands-on experience in the use of many analytical instruments such as Atomic absorption spectrometer and Karl Fischer Titration instrument in Instrumental Analysis and Quantitative Analysis laboratory courses. Hands-on experience using the atomic absorption spectrometer and KFT instruments allows students to better understand and relate the theoretical principles discussed in the lecture and the practical operation of atomic absorption spectroscopy and Electro. Furthermore, the experiment significantly improved the students’ confidence in sample preparation and instrument handing and made students comfortable using analytical instrumentation for chemical analysis.

Second, the GI program has overtly generated excitement among underrepresented STEM students, while promoting critical thinking, teamwork, and leadership skills. Third, the majority of the GI
Institution: Winston-Salem State University Team 2 Cont’d

Participants enjoyed working in teams. Teamwork also facilitates and promotes individual efforts and ensures collective responsibly in a laboratory setting and allows students to freely learn from their group members. Furthermore, teamwork also encourages constructive criticism among peers and motivates each other, ultimately allowing students to be more focused and successful in the laboratory experience. Student surveys also indicated that students in the GI section had less anxiety working with chemicals than their peers. As a matter of fact, all student participants in the GI lab (who were also GI lab pioneer-participants in General Chemistry, Organic Chemistry, Physical Chemistry, Quantitative Analysis laboratory at WSSU) have graduated and are currently either in medical, pharmacy, or graduate school, or working in industry. Overall our GI-based experiment is a tremendous success, promoting student learning in STEM at WSSU.
Technology-enhanced Strand
Institution: Jackson State University Team 1

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**Brief Description of STEM Instructional Strategy:** In addition to a brief description of the strategy, include discipline; course; target student group (classification); and duration of intervention (summer, fall semester, spring semester, full academic year).

Jackson State University (JSU) is a Historically Black institution located in Jackson, the capital city of the State of Mississippi. It plays a major role in providing high quality education and research to underrepresented African-American students. The purpose of this project was to implement evidence-based instructional strategies into General Biology courses for freshmen majoring in biology through infusing technology via Blackboard. The strategies that were used included: computerized hands-on activities, discussions and debates of current events related to biology, collaborative environment through small-group work, student presentations and interactive learning stations.

The course was designed with the intention of students learning the basic materials presented in the class (on-line) and to increase their scientific knowledge of biological concepts and skills.

**Brief Description of Institutional/Departmental (Non-anecdotal) Evidence of Strategy’s Effectiveness:**

The Department of Biology at Jackson State University uses several measurement outcomes and interventions to assess the success of students. These measurement outcomes include assays, research theses, quizzes, oral presentations, homework assignments, tests, individual and group projects and demonstrations. The formal process of assessment is in using evidenced based strategies such as: Access student for knowledge of concepts and skills in biology through the Blackboard medium; actively involve students through asking questions using various formats (structure, convergent, divergent, Socratic), not to exclude assessment instruments to measure computer skills using tests and quizzes on course content; provide students with the information needed to acquire resources for the course (syllabus, computer access, exemplars, video/audio lessons, etc.); appraise student work utilizing rubrics, rating scales, and checklist; apply the practices that have proved to increase productively as evidenced in student work (product or performance). This assessment processes allows for meta-evaluation to occur as practices evolve.

Utilizing the evidence best practices, in 2009, Dr. Yedjou and his collaborators conducted a study between online and traditional learners in an Intro to Biology course and found that students performed similarly in both face-to-face and online class; online students self-reported a higher rating of class. The
findings were consistent with previous analysis from the Institute for Higher Education Policy Report, indicating that learning outcomes of students in online courses are similar to those of students in traditional classes. The attitudes, based on self-report, of the distance learners were generally more positive than the student who took the traditional course. Data generated from this study showed that traditional and online courses can be very successful when using technology as a tool to enhance the course.

The course evaluation process was summative and quantitative using three sources of data collection:
1. Student Instructional Ratings Survey (SIRS) – an instrument administered to students to rate the course content, teaching methodology, methods of instruction, and the professor.
2. Student Survey – developed by the researcher, this survey included self-reported questions on Likert scale about the course experience.
3. Student Grades – measurement based on the assignment (discussion board, presentations, etc.) graded using rubrics, rating scales, and checklists. Inter-rater reliability was not used to validate the assigned grades.

The baseline data was collected in the first semester courses. The data was collected and used to make inference for the total population of students.
Quality Education for Minorities (QEM) Network
Effective Institutional STEM Instructional Strategies at HBCU-UP Grantee Institutions

Institution: Jackson State University Team 2, Submission 1

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Brief Description of STEM Instructional Strategy- In addition to a brief description of the strategy, include discipline; course; target student group (classification); and duration of intervention (summer, fall semester, spring semester, full academic year).

To improve Jackson State University Meteorology students’ research capabilities and chances for research internships, a data analysis and computational course (MET 270) was implemented targeting sophomores. Students are first introduced to programming languages in the MET 303 lab in the fall, then take the course in the spring. During the summer, when the students do their internships, they will be able to apply their knowledge to real world exercises. This course then assists the students in their senior year when they take MET 431 (Numerical Methods).

Brief Description of Institutional/Departmental (Non-anecdotal) Evidence of Strategy’s Effectiveness:

The effectiveness of this strategy is measured in two ways. First, by the degree of their internship experience to handle programming, and secondly, by their MET 431 instructor. A tertiary evaluation is done during their junior and senior year when those students who are engaged in undergraduate research projects complete their individual research projects for presentation at either NCUR or AMS conference.
Quality Education for Minorities (QEM) Network
Effective Institutional STEM Instructional Strategies at HBCU-UP Grantee Institutions

Institution: Jackson State University Team 2, Submission 2

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**Brief Description of STEM Instructional Strategy:** In addition to a brief description of the strategy, include discipline; course; target student group (classification); and duration of intervention (summer; fall semester, spring semester, full academic year).

To improve Jackson State University Meteorology students’ research and graduate studies capabilities, MET 472 (Independent studies) is taught to research oriented undergraduates throughout their academic matriculation. Year 1 involves group meetings and classes on the scientific method and how to write a research paper. Year 2 involves development of a research topic and development of the literature review. Year 3 involves implementing research and preparing to present results in the senior year at a major conference (NCUR or AMS).

**Brief Description of Institutional/Departmental (Non-anecdotal) Evidence of Strategy’s Effectiveness:**

The effectiveness of this strategy is measured by students’ ability to complete their research, present at a major conference (preferably giving an oral presentation), and be accepted for publication. An example of this is our most recent graduate who has been accepted to Penn State, published at NCUR in her junior year and presented orally at NCUR. Our current evidence consists of a junior who is scheduled to present orally at AMS in January.
Quality Education for Minorities (QEM) Network  
Effective Institutional STEM Instructional Strategies at HBCU-UP Grantee Institutions

Institution: Jackson State University Team 2, Submission 3

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**Brief Description of STEM Instructional Strategy:** In addition to a brief description of the strategy, include discipline; course; target student group (classification); and duration of intervention (summer; fall semester; spring semester; full academic year).

**The Jackson State University Meteorology Department, through its laboratory courses (MET 219, 299, 399 and 421), incorporates an undergraduate matriculation strategy to assess student improvement in applied meteorology.** MET 219 provides basic instructions on how to plot weather maps (temperature, pressure, dewpoint). MET 299 builds on 219 but expands to include various pressure levels, multiple parameters on a single plot, and interpretation. MET 399 further expand the previous courses by applying basic theory students learn up to their junior year to map analysis.

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**Brief Description of Institutional/Departmental (Non-anecdotal) Evidence of Strategy’s Effectiveness:**

The effectiveness of the MET 219, 299 and 399 courses becomes evident when the students take MET 421 at the end of their junior year. At this point, students are assessed on their ability to produce timely, clean, accurate maps while interpreting the results to assess the state of the atmosphere and make a weather forecast.
Institution:  Jackson State University Team 3

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**Brief Description of STEM Instructional Strategy:** In addition to a brief description of the strategy, include discipline; course; target student group (classification); and duration of intervention (summer, fall semester, spring semester, full academic year).

**The instructional strategy for visual analytics and data mining is the train-the-trainer model.** Graduate students will be trained to train the undergraduate students. Then, the undergraduate students will train the high school students. The intervention has been successfully implemented as a summer program for the last four years. The intervention will be replicated during summer for the next three years.

**Brief Description of Institutional/Departmental (Non-anecdotal) Evidence of Strategy’s Effectiveness:**

We enrolled in the Center for Bioinformatics & Computational Biology 20 students, 15 students, 32 students, and 25 students during the summer in 2009, 2010, 2011 and 2012 respectively. Seven graduate students were sent to Iowa State University for GIS training, where they received certification of 22 units in Esri. The training at Iowa State in 2011 was a two-week period of extensive training in the aforementioned Esri. The graduate students who participated in the program have completed their graduate studies. One of them is a full-time faculty; another is employed and setting exams for GED; and the others have gone on to pursue another master’s degree. The high school students who participated in the program are now in the process of entering various universities and the undergraduate students are completing their programs of study.
Quality Education for Minorities (QEM) Network
Effective Institutional STEM Instructional Strategies at HBCU-UP Grantee Institutions

Institution: Langston University Team 1

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<table>
<thead>
<tr>
<th>Brief Description of STEM Instructional Strategy</th>
<th>In addition to a brief description of the strategy, include discipline; course; target student group (classification); and duration of intervention (summer; fall semester; spring semester; full academic year).</th>
</tr>
</thead>
<tbody>
<tr>
<td>Competency Performance Recordings for Learning (CPRL) Description: CPRL is a teaching and learning process aimed at “resuscitating” student’s learning of the analytical process of problem solving. It enhances their problem solving skills as well as their understanding of core course concepts. It is a system (learning by teaching) that helps students identify and apply core course concepts to problem solving in an iterative way. The student is guided by a set of rubrics and, with the aid of a tablet PC, the student is required to produce an audio/visual recording of the solution-finding process, thus emulating a (teacher) role. Protocols and concepts in LU’s CPRL activities are recognized throughout literature. The CPRL teaching method has been used in teaching: (1) SABC/STEM Double Bridge chemistry class during four-week summer sessions from 2009-2012; (2) special colloquia for chemistry (CH1315); and (3) special research colloquia for LINC STEM majors.</td>
<td></td>
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<tr>
<th>Brief Description of Institutional/Departmental (Non-anecdotal) Evidence of Strategy’s Effectiveness:</th>
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<tbody>
<tr>
<td>Impact of CPRL on SABC/STEM Summer Double Bridge Chemistry class: There was a 41% grade improvement (Traditional teaching methods vs. CPRL teaching method) in 2009; a 110% grade improvement (Traditional teaching methods vs. CPRL teaching method) in 2010 &amp; 2011; and a 212% improvement in 2012.</td>
</tr>
<tr>
<td>Impact of CPRL on Class GPA: Students who attended Organic chemistry colloquium classes using CPRL teaching methods realized an improved GPA of 1.2 points over non-colloquium attendees. Students who attended General Chemistry colloquium classes using CPRL teaching methods realized an improved GPA of 1.3 points over non-colloquium attendees.</td>
</tr>
<tr>
<td>LINC STEM scholars research presentation performance garnered in excess of a 50% increase in regional and national awards when CPRL was used as primary methodology for teaching Introduction to Chemical Research, including elements of presentation. Pre-CPRl awards: 2005 - 4; 2006 - 3. With CPRL: 2007 - 5; 2008 - 10; 2009 - 10; 2010 - 8; 2011 - 8.</td>
</tr>
<tr>
<td>Evaluation: Formative evaluations given throughout course assess impact of CPRL learning activities on students’ performance as well as on-going progress. Summative evaluation at pre-determined milestones</td>
</tr>
</tbody>
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Quality Education for Minorities (QEM) Network
Effective Institutional STEM Instructional Strategies at HBCU-UP Grantee Institutions

Institution: Langston University Team 1 Cont’d

provides an assessment of the project’s outcomes as measured against stated goals, including students’ GPA as well as performance on standardized exams.

QEM Workshop Presentations provided valuable resource information in areas of effective teaching strategies, project evaluation tools, and barriers to learning.
Quality Education for Minorities (QEM) Network
Effective Institutional STEM Instructional Strategies at HBCU-UP Grantee Institutions

Institution: Lincoln University, Missouri

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Brief Description of STEM Instructional Strategy: In addition to a brief description of the strategy, include discipline; course; target student group (classification); and duration of intervention (summer, fall semester, spring semester, full academic year).

Pre-calculus is a unified course with the same content as College Algebra and Trigonometry. Pre-calculus is one of the prerequisites for STEM majors. It was offered both the fall semester and spring semester in the academic year 2011 and 2012. The targeted group was the students who major in STEM or consider majoring in STEM.

Teaching Strategy: Cooperative learning groups were the main teaching strategy. Students were divided into eight groups based on their majors. Each group was in charge of one of the following core concepts: solve inequalities; domain of composite functions; graph rational functions; solve trigonometric functions; solve logarithm functions; law of cosines and sines; trigonometric form of complex numbers; and graph trigonometric functions. Online tutorial videos were the supporting materials for group presentation. Students used the videos as presentation examples and to study for homework and tests. Each presentation included three parts: Introduction—understanding core concepts; Applications—examples in their majors; and Summary—key ideas in solving the applications.

Brief Description of Institutional/Departmental (Non-anecdotal) Evidence of Strategy’s Effectiveness:

AY 2011, the retention rate was 19/27 = 70.37% and the passing rate was 15/19 = 78.95%. AY 2010, the retention rate was 19/28 = 67.86% and the passing rate was 17/19 = 89.47%. Comparing the data: The retention rate remained stable under the new model of teaching Pre-calculus. The passing rate slightly decreased. Outcomes Assessment: On the final exam, students scored higher on the core questions. Evidence: Students who passed Pre-calculus obtained better grades in Calculus.
Quality Education for Minorities (QEM) Network  
Effective Institutional STEM Instructional Strategies at HBCU-UP Grantee Institutions

Institution: Morgan State University Team 2, Submission 1

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**Brief Description of STEM Instructional Strategy:** In addition to a brief description of the strategy, include discipline; course; target student group (classification); and duration of intervention (summer, fall semester, spring semester, full academic year).

**To engage in a "real-world" problem context that provides practical application to supplement in-class instruction and enhance the overall student learning experience. For example, a bridge inspection field trip was planned as part of the PI's HBCU-UP grant to aid students in identifying various components of a bridge needed to conduct research about bridges.** Seven students explored the five-span multi-beam steel bridge and were engaged in a bridge inspection "lesson" at a bridge near campus, where the inspection was facilitated by a local bridge engineer/inspector. This strategy was targeted for undergraduate student researchers, ranging from freshman to senior status, working in Dr. Head's research group. After returning from the field visit, students were evaluated based on their ability to actually label the components of a 2D bridge to ensure effectiveness of problem context. Note that the field visit can be conducted in larger groups. The duration of the visit was for one hour during the fall semester to achieve this specific objective. However, additional visits to the bridge can be arranged and extended so that students can explore the connection details of the cross-frames into the steel beams, and compare to their designs.

**Brief Description of Institutional/Departmental (Non-anecdotal) Evidence of Strategy’s Effectiveness:**

**Effectiveness:** The evidence in this strategy's effectiveness is documented in part by the outcomes that must be addressed by the MSU Department of Civil Engineering through the Accreditation Board of Engineering and Technology (ABET) criteria, which states that engineering students must be able to "identify, formulate and solve civil engineering problems." From the site visit, 90% of the students were able to identify all bridge components and determine how the bridge was rehabilitated after reviewing the bridge inspection report showing photos of the bridge prior to rehabilitation. Eight-five percent (85%) of students who attended the visit were able to compare and contrast at least two levels of damage when evaluating the bridge in its 2007 condition versus the rehabilitated bridge as of 2011.
Quality Education for Minorities (QEM) Network  
Effective Institutional STEM Instructional Strategies at HBCU-UP Grantee Institutions

Institution: Morgan State University Team 2, Submission 1 Cont’d

Evidence-Based Strategy: Students will apply knowledge learned from the bridge inspection lesson to the research project presented in this research initiation grant to: (1) develop Leadership in Energy and Environmental Design (LEED) ratings; and (2) design bridge columns with AFRP composite rebar that will result in high performance green bridges (HPGB). The students are exposed to specific real-world problems and state-of-the-practice via scholarly papers and industry-sponsored webinars as a means to aid in diagnosing the problems to engineer solutions to develop the LEED criteria and design of concrete bridge columns with these innovative composite materials to achieve a unique function of enabling the column to be seismic-resistant as well as corrosion-resistant due to it being a composite (plastic) material that is inherently corrosion-resistant. During the bridge visit, students show evidence of their learning by labeling the general bridge components as revealed during the bridge inspection lesson.

Assessment

Formative: Students will write and post findings related to the LEED rating system criteria and synthesize information read from scholarly papers to an online discussion board via Blackboard. A critical component of the postings is encouraging students to write more and provide them with feedback to help them enhance their critical thinking and writing skills. Online feedback by Dr. Head as well as the other researchers to foster the research thinking and learning community. The online forum is an interactive way to discuss research throughout the week, where culminating discussions take place during the weekly brown bag lunch meetings called "lunch and learn" seminars.

Summative: After the bridge inspection visit, students were queried about the different bridge components and were asked to label them on the whiteboard as a group exercise to confirm subject mastery. Students will submit bi-weekly progress reports of their findings from the literature review and structural design for the bridge columns. Students will also conduct experimental testing to validate their design. Coupled with experimental testing is the development of simple analytical models, which will serve as a capstone exercise and assessment of learning from the entire research project as it demands subject mastery from the students in order to properly use structural analysis to simulate the behavior. Anticipated behavior can be modeled and predicted via parametric studies on the bridge column with AFRP rebar when subjected to various simulated earthquake ground motions. The project will conclude with design examples that the students will create and provide elegant solutions to aid with promoting "research-to-practice" for industrial professionals who are interested in the research as being a new trend for the current "state-of-the-art" and "state-of-the-practice" for bridge and earthquake engineering.

Student Learning: Student learning takes place during the "real-world" problem context visits and development of the final design examples, which showcase and validate the research proposed. Students will present their findings of what they've learned at a conference, where they will also disseminate the results from the research project. Students will really see the impact of their findings and validation of their learning when the results are published in conference papers and other scholarly publications. Students will also exhibit what they've learned by posting their body of work from the research in an e-Portfolio generated in Blackboard, where employees or other interested parties can see what they have done and assess their quality of work.
Program Evaluation: Dr. Head will evaluate student performance by reviewing and providing feedback on the students' bi-weekly progress reports as well as keeping track of the students' grades. Students will have the opportunity to write research abstracts and manuscripts, where Dr. Head will provide guidance on technical writing and provide feedback to students on their writing skills. The research experience should help the students to succeed in the classroom given the exposure to more information and assistance with critical thinking and higher order skill sets demanded by the research. Dr. Head will evaluate her effectiveness as a mentor by tracking the number of researchers who apply and attend graduate school.
Quality Education for Minorities (QEM) Network
Effective Institutional STEM Instructional Strategies at HBCU-UP Grantee Institutions

Institution: Morgan State University Team 2, Submission 2

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**Brief Description of STEM Instructional Strategy:** In addition to a brief description of the strategy, include discipline; course; target student group (classification); and duration of intervention (summer, fall semester, spring semester, full academic year).

To design a prototype model of a truss bridge in order to visualize which members are in compression or tension when loaded. Given that engineering is inherently a team-oriented field with civil engineering involving a lot of visualization of proven analytical concepts, it is important for students to gain a "feel" for the physical context of structures when members are acting in compression or tension when loaded. **Students in an undergraduate Introduction to Civil Engineering course, consisting primarily of freshman and sophomore students at MSU during the Spring 2012 semester, were asked to design and build a prototype of any truss bridge to understand load path and visualize which members are in compression or tension when loaded as one 2-week long activity that was one deliverable within a group bridge design project that lasted the entire semester utilizing the West Point Bridge Design software.** In other words, after building the prototype, students were to model and load it using the software that had virtual trucks, which could traverse their bridge model and show, which elements were actually in compression and tension. Students were to compare and contrast the different load cases, and explain which members were in compression or tension and why.

**Brief Description of Institutional/Departmental (Non-anecdotal) Evidence of Strategy’s Effectiveness:**

**Effectiveness:** The evidence in this strategy's effectiveness is documented in part by the outcomes that must be addressed by the MSU Department of Civil Engineering through the Accreditation Board of Engineering and Technology (ABET) criteria, which states that engineering students must be able to work in multidisciplinary teams, design experiments, and communicate effectively in oral and written forms. 75% of students were able to explain their understanding of how compression and tension works during their in-class oral presentations, which had to be validated by the analytical simulation conducted via the *West Point Bridge Designer*. Results showed that 60% of the groups who constructed high-quality, precise models also received higher project grades.
Institution: Prairie View A&M University

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Brief Description of STEM Instructional Strategy- In addition to a brief description of the strategy, include discipline; course; target student group (classification); and duration of intervention (summer; fall semester; spring semester; full academic year).

We proposed to incorporate digital ink and interactive white boards into the classroom to enhance student learning, attract students, and organize active and collaborative activities. The project duration is from September 2010 to August 2013. We chose several targeted courses such as “Computer Science II,” “Data Structures,” and “Software Engineering.” The students are widely diversified from Freshman to Senior, including a number of minority and female students.

Brief Description of Institutional/Departmental (Non-anecdotal) Evidence of Strategy’s Effectiveness:

So far, we have pilot-tested the developed course materials and students’ feedback is promising. Many students indicated that the new technologies adopted increased their learning interests and interaction with instructors. It also helped deliver course materials and administer exams.
Quality Education for Minorities (QEM) Network  
Effective Institutional STEM Instructional Strategies at HBCU-UP Grantee Institutions  

Institution: Southern University at Baton Rouge Team 2

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**Brief Description of STEM Instructional Strategy**-
In addition to a brief description of the strategy, include discipline; course; target student group (classification); and duration of intervention (summer, fall semester, spring semester, full academic year).

The traditional mode of instruction of the subject of heat transfer, a required senior-level mechanical engineering course, focuses on the presentation of the theory through mathematical derivations and lecture presentation of solution methodologies for solving heat transfer problems. **The new strategy under consideration involves dividing the course into modules based on real-world application problems to act as drivers to set the stage for the theory and draw students’ attention and interest before presentation of the theory and pertinent solution strategies.** This approach should enhance students’ visualization of heat transfer problems, especially with the added use of computer animations to create visual effects.

Duration of intervention: fall semester or spring semester.

**Brief Description of Institutional/Departmental (Non-anecdotal) Evidence of Strategy’s Effectiveness:**

Course outcome data will be collected at the end of the fall 2012 semester. This data will be compared to available baseline data and analyzed to discern the effectiveness of the learning strategies being implemented in the heat transfer course. Live Text has been adopted at Southern University to be used for strategic planning, assessment, and institutional effectiveness. In the heat transfer course, Live Text is being customized for web-based assessment to allow for seamless integration and data reporting to effectively measure course and institutional objectives for accreditation and continuous improvement.

Assessment Strategy: Formative assessment will involve: (1) quick surveys to gauge student attitudes towards individual modules; (2) homework and open-ended projects; and (3) local quizzes. Summative assessment will involve tests including the final exam.
Quality Education for Minorities (QEM) Network
Effective Institutional STEM Instructional Strategies at HBCU-UP Grantee Institutions

Institution: Southern University at Baton Rouge Team 2 Cont’d

Evaluation Plan: Attitude surveys will be evaluated to determine how student motivation and perception of learning was affected by the experience using the modules. If surveys reflect that students prefer the modules and they feel more confident in the learning gained from them, then the modules should be continued and/or further developed. Student scores on homework assignments, quizzes, and projects will inform the success of individual modules. Student scores on quiz and test questions based on topics covered with the modules will be compared between semesters when the modules were employed versus when they were not. An improvement of scores with the use of the modules will indicate success of the module strategy and they should be continued and/or further developed. This evaluation will occur each semester the course is offered.
Quality Education for Minorities (QEM) Network
Effective Institutional STEM Instructional Strategies at HBCU-UP Grantee Institutions

Institution: Spelman College, Submission 2

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Brief Description of STEM Instructional Strategy - In addition to a brief description of the strategy, include discipline; course; target student group (classification); and duration of intervention (summer, fall semester, spring semester, full academic year).

Building on Strong Foundations: Improving Student Retention and Matriculation in the Major: In order to address attrition issues regarding majors in the department and to improve retention of basic chemistry concepts at the freshman level, in 2009 one of the General Chemistry course sections at Spelman was designated primarily for first-year students majoring in Chemistry and Biochemistry. The course has employed student-centered pedagogies including process-oriented guided inquiry learning (POGIL) and subject mastery assessments (online homework systems and “gated” tests). The student cohort was maintained throughout the General and Organic Chemistry course sequence. The Organic Chemistry course also promotes student-centered learning through POGIL, online skill development, virtual tutorials, and learning through computer-based molecular modeling. As of the 2012-13 Academic Year, both courses have been revised to incorporate online video lectures so that class time is spent primarily on team-based projects and problem-solving, demonstrations, question and answer sessions, and skill building exercises (ChemDrills). The aim of this “flipped” classroom format is to increase active learning while promoting (and assessing) subject mastery. In addition, having the first-year and the second-year majors in a single course section encourages cohesion among this cohort of students that is retained throughout their time in the major.

Brief Description of Institutional/Departmental (Non-anecdotal) Evidence of Strategy’s Effectiveness:

Assessment: While pre- and post-exams are used to assess student learning in both General and Organic Chemistry, additional methods are used to examine students’ learning patterns, ability to identify the various components of a given concept, and approach to problem solving. Tools used for these purposes include gated exams for students in General Chemistry, which not only to determine mastery, but the rate at which mastery occurs. In addition, problem-based reflections are used in Organic Chemistry to determine students’ problem solving process. The reflections are graded using a rubric and are used for peer assessment and feedback. In addition, clicker quizzes and live or online blogs are used to create a dynamic and interactive way of monitoring skill development and assessing student engagement. The success of students in the learning communities has been monitored for the last three years. However, this is the first year that the “flipped classroom” format has been used.
**Quality Education for Minorities (QEM) Network**  
**Effective Institutional STEM Instructional Strategies at HBCU-UP Grantee Institutions**  

**Institution:** Spelman College Team 1, Submission 2 Cont’d

| **Evaluation:** The evaluation strategies will focus on defined long-term goals impacting student retention within the chemistry major, success in first and second year courses, and acceptance into competitive graduate and professional programs. In addition, evaluations plan will assess the development, utility, and usefulness of resources incorporated into the general and organic chemistry courses: animated lectures, skill building exercises that will allow students to master basic concepts, and rubrics for assessing critical thinking and problem solving. |
Quality Education for Minorities (QEM) Network
Effective Institutional STEM Instructional Strategies at HBCU-UP Grantee Institutions

**Institution: Virginia State University Team 2, Submission 1**

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**Brief Description of STEM Instructional Strategy**  
In addition to a brief description of the strategy, include discipline; course; target student group (classification); and duration of intervention (summer, fall semester, spring semester, full academic year).

**Our generalizable and replicable proposed strategy, “Regional Collaboration as a Tool to Increase STEM Teaching and Learning Capacities and Capabilities,” will be an expansion of the unique, first-of-its-kind collaboration between academic, non-academic, manufacturing and industrial partners (called “Commonwealth Center for Advanced Manufacturing” or CCAM; a consortium of eight global industries and manufacturers and three universities: VSU, UVA and VA Tech) to accelerate collaborative research projects in two specific areas of engineering at VSU: (1) surface engineering, which includes automotive, aerospace/aeronautical, energy, electronics, biomedical, textile, petroleum, materials manufacturing and construction industries, all having surface engineering needs; and (2) manufacturing systems which efficiently integrate processes associated with the conceptualization, design, production and service of manufactured parts including computer-aided manufacturing and process planning, production execution, virtual manufacturing systems, integration of manufacturing data into the design process, and additive manufacturing processes and opportunities. The target student group involves 15 undergraduates from sophomore to senior-level classes. The intervention will continue over the full academic year until students’ graduation.

**Brief Description of Institutional/Departmental (Non-anecdotal) Evidence of Strategy’s Effectiveness:**

VSU’s engineering undergraduates will directly be able to conduct research in CCAM’s upcoming 50,000 square-foot, state-of-the-art research facility near Petersburg, Virginia (adjacent to Rolls-Royce’s new jet engine components plant) with about 60 full-time staff members, expected to be employed there eventually. In addition to having hands-on learning opportunities from industry experts, the collaboration will initiate targeted employment of eligible VSU engineering graduates. Thus, VSU’s increased lab capability and capacity will not only help reduce the university’s overall costs but also advance regional economic growth.
Quality Education for Minorities (QEM) Network  
Effective Institutional STEM Instructional Strategies at HBCU-UP Grantee Institutions

Institution: Virginia State University Team 2, Submission 2

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**Brief Description of STEM Instructional Strategy:** In addition to a brief description of the strategy, include discipline; course; target student group (classification); and duration of intervention (summer, fall semester, spring semester, full academic year).

Our strategy is to capitalize on our newly-forged collaboration with private industry and other regional institutions of higher education by investing in emerging technologies and enhancing our students’ ability to compete globally for manufacturing jobs. **To achieve this goal, our generalizable and replicable proposal of creating an on-campus “Advanced Manufacturing Education Center” (AMEC) is a unique, first-of-its-kind venture in the region (Virginia, Maryland, and other neighboring states). The grant funds will be used to streamline our undergraduate manufacturing engineering curriculum in closing competency-related gaps between student-learning vs. market needs. In addition, the AMEC will enhance students’ knowledge in advanced manufacturing by implementing a two-year internship program.** Eligible students will be first offered on-campus internships during the first year’s summer, complemented by on-site placement in the manufacturing industry nationwide during the summer of the second year. The proposal not only targets manufacturing engineering discipline but involves students in computer engineering, mechanical engineering technology, and electronics engineering technology.

**Brief Description of Institutional/Departmental (Non-anecdotal) Evidence of Strategy’s Effectiveness:**

VSU’s existing manufacturing engineering is a unique, exclusive program that offers the exclusive ABET (Accreditation Board for Engineering and Technology)-accredited Bachelors of Science in Manufacturing Engineering degree in the region, including Maryland, whose students are channeled to VSU per the Commonwealth’s agreement with the State of Maryland. The proposed strategy capitalizes and expands the multi-dimensional facets of pedagogical practices though a shared use of our university’s multiple collaborators’ capabilities and capacities, primarily engineering labs and facilities. For example, VSU’s engineering undergraduates will directly be able to conduct research in CCAM’s (Commonwealth Center for Advanced Manufacturing) 50,000 square-foot, state-of-the-art research facility near Petersburg, Virginia (adjacent to Rolls-Royce’s new jet engine components plant). In addition to having hands-on learning opportunities from industry experts, the collaboration will initiate targeted employment for eligible VSU engineering graduates. Thus, VSU’s increased lab capability and capacity will not only help reduce the university’s overall costs but also advance regional economic growth.
Quality Education for Minorities (QEM) Network
Effective Institutional STEM Instructional Strategies at HBCU-UP Grantee Institutions

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Quality Education for Minorities (QEM) Network
Effective Institutional STEM Instructional Strategies at HBCU-UP Grantee Institutions
Appendix A: Workshop Agenda

Quality Education for Minorities (QEM) Network
Workshop on Evidence-based STEM Instructional Strategies
Supported by the National Science Foundation (NSF)
Four Points by Sheraton Hotel at BWI Airport
1001 Scott Drive • Baltimore, MD • 410/859-3300
November 9-10, 2012

Workshop Goals:
(1) to enhance the Participants’ awareness and understanding of methodologies for assessing and evaluating the effectiveness of STEM Instructional Practices; and
(2) to share information on Evidence-based STEM Instructional Practices being used at NSF/HBCU-Undergraduate Program (HBCU-UP) Grantee Institutions.

FRIDAY

AM
8:00 Registration and Continental Breakfast

8:30 Welcome and Introductions
Shirley McBay, President, QEM Network

8:45 The Scholarship of Teaching and Learning (SOTL) – Advancing the Practice of Teaching through Research
Presenter: Josephine Davis, Professor, Department of Mathematics
Fort Valley State University, and QEM Consultant

9:15 Assessment and Evaluation of Student-centered STEM Instructional Strategies
Presenter: Emorcia Hill, Director, Research and Evaluation, Converge Office for Diversity and Community Partnership
Harvard Medical School, and QEM Consultant

10:00 Questions and Answers

10:15 Implementation of a Student-centered STEM Instructional Strategy
Presenter: John Coleman, Associate Professor and Chair
Department of Chemistry, Langston University
Topic: Competency Performance Recordings for Learning (CPRL)

10:30 Break
10:45  
**Assessment and Evaluation of Instructional Strategies used in Mathematics and Computer Science**  
Presenter: Kimberly Kendricks, Associate Professor of Mathematics  
Department of Mathematics and Computer Science  
Central State University, and QEM Consultant

11:15  
**Questions and Answers**

11:30  
**Implementation of Instructional Strategies in Mathematics and Computer Science**  
**Presenters:** Qingxia Li, Assistant Professor, Department of Mathematics  
Lincoln University of Missouri  
Lauretta Garrett, Assistant Professor, Department of Mathematics  
Tuskegee University  
**Moderator:** Nafeesa Owens, Associate and Project Coordinator, QEM Network

**NOON/PM**

12:00  
**Working Lunch: Presentations on the Use of Supplemental Instruction in STEM**  
**Presenters:** Barbara Cady, Professor  
Department of Communicative Sciences and Disorders  
Alabama A&M University  
Susan Safford, Professor, Department of Biology  
Lincoln University of Pennsylvania

1:30  
**Assessment and Evaluation of STEM Teacher Preparation-focused Instructional Strategies**  
**Presenter:** Josephine Davis, QEM Consultant

2:15  
**Questions and Answers**

2:30  
**Implementation of a STEM Teacher Preparation-focused Instructional Strategy**  
**Presenter:** Winona Taylor, Professor and Chair  
Educational Studies and Leadership  
Bowie State University  
**Topic:** Modular Instructional Workshops

2:45  
**Break**

3:00  
**Concurrent Sessions:** Description of Evidence-based STEM Instructional Practices by Institutional Teams

4:30  
**Assessment and Evaluation of Technology-focused STEM Instructional Strategies**  
**Presenter:** Clay Gloster, Jr., Professor and Chair  
Department of Electronics, Computer, and Information Technology  
North Carolina A&T State University

5:15  
**Questions and Answers**
5:30  Implementation of a Technology-focused STEM Instructional Strategy  
   Presenter: Moustapha Diack, Professor  
   Department of Science/Mathematics Education  
   Southern University at Baton Rouge  
   Topic: Quality Matters (QM)- Certification of Online and Blended Courses

5:45  Break

6:00  Working Dinner: Table Discussion of the Day’s Presentations

7:30  Adjournment

SATURDAY

AM
9:00  Questions and Comments Regarding Day One Discussions

9:30  NSF Funding Opportunities for Implementation of Evidence-based Strategies  
   - Expeditions in Education (E2)  
   - K-16 Math Education (Partnership with the Department of Education)  
   - Transforming Undergraduate Education in Science, Technology, Engineering and Mathematics (TUES)  
   - Supplements to existing HBCU-UP award/Targeted Infusion Projects  
   - WIDER Solicitation  
   Presenter: Althea Burns, Associate and Conference Coordinator, QEM Network

10:15  Break

10:30  Concurrent Sessions: Institutional Teams Discuss Proposal Ideas for Implementation of Evidence-based Instructional Strategies

NOON
12:00  Working Lunch: Key Steps in Proposal Preparation  
   Presenter: Shirley McBay, QEM Network

1:30  Closing Comments and Next Steps

2:00  Adjournment
Quality Education for Minorities (QEM) Network
Effective Institutional STEM Instructional Strategies at HBCU-UP Grantee Institutions
Appendix B: List of Workshop Participants

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Dr. Gloster has conducted research in the areas of reconfigurable computing, technology-based curriculum development, and distance education. He has published more than 30 papers in peer-reviewed conferences/journals. His current research focuses on the development of software tools that allow scientists to benefit from the potential order of magnitude speedup in execution time offered by reconfigurable computers over typical desktop computers. These tools significantly reduce algorithm development time by transforming C/C++ programs into an assembly language program that can be executed directly on a reconfigurable computer.

Dr. Gloster has received numerous fellowships from organizations including NASA Goddard Space Flight Center and the Office of Naval Research. He earned both the B.S. and M.S. degrees in Electrical Engineering at North Carolina A&T State University and the Ph.D. degree in Computer Engineering from North Carolina State University.
HILL, Emorcia
Emorcia Hill is Director, Research and Evaluation at Converge, which is housed in the Harvard University Medical School. She has more than twenty years of experience in the design, implementation, and evaluation of educational and child welfare programs. Dr. Hill has significant experience in the design of research projects, and quantitative and qualitative data analysis. She served as Senior Director of the Excellence Through Diversity Program at the New England Board of Higher Education, where she established and implemented program priorities for a region-wide network to improve the participation and success of minority students and professionals in higher education and industry.

Dr. Hill worked for five years at Abt Associates, Inc., where much of her work concentrated on various aspects of evaluations related to STEM. In addition to assessing program impact and implementation, these evaluations provided data essential for analytical and policy support, program monitoring, and reporting requirements. Dr. Hill’s higher education evaluation projects have included NSF’s Faculty Early Career Development Program, Graduate Research Traineeships, and Integrative Graduate Education and Research Traineeship (IGERT). She received the Ph.D. degree in Sociology from Boston College. Her dissertation examined the class structure of academia and the factors that inhibit or facilitate success of scientists and engineers in institutions of higher education.

KENDRICKS, Kimberly
Kimberly Kendricks is Associate Professor in the Department of Mathematics and Computer Science at Central State University (CSU). Since joining CSU in 2007, Dr. Kendricks has served as the Principal Investigator or Co-Principal Investigator on multi-million dollar CSU grants as well as collaboratively with neighboring institutions. In her research, which is supported by NSF, the American Society for Engineering Education, and the National Signature Program, she takes mathematical theories and applies them to real world problems in robotics and gait analysis. Dr. Kendricks has a sincere passion for mathematics and mathematics education and aims to increase the success rate of students in mathematics, particularly minority students, thereby increasing the number of students earning a STEM degree. Through her work in the classroom, she has increased the success rate of students taking College Algebra, Trigonometry, and Differential Equations by over 20 percent.

Dr. Kendricks also serves on the governing board of the Dayton Regional STEM School and works collaboratively with the Air Force Institute of Technology, Wright State University, and the University of Dayton to promote the advancement of women faculty in STEM through an NSF-ADVANCE project. She recently completed the QEM/NSF HBCU-UP Leadership Development Institute, which served to shape and support her future pursuits in the academy. Dr. Kendricks received a dual degree in Mathematics and Business from the University of Pittsburgh and Master’s and Ph.D. degrees in Mathematics from Auburn University.
Glossary of Instructional Strategies, Assessment Methodologies, or Instruments
Found in the Templates Submitted by Workshop Participants

Blended Learning
“In general terms, blended learning combines online delivery of educational content with the best features of classroom interaction and live instruction to personalize learning, allow thoughtful reflection, and differentiate instruction from student to student across a diverse group of learners.”


Collaborative Learning
“The term ‘collaborative learning’ refers to an instruction method in which students at various performance levels work together in small groups toward a common goal. The students are responsible for one another's learning as well as their own. Thus, the success of one student helps other students to be successful.”


Force Concept Inventory
“The Force Concept Inventory is a multiple-choice test designed to monitor students’ understanding of force and related kinematics.”


Formative Assessment
“Formative Assessment is part of the instructional process. When incorporated into classroom practice, it provides the information needed to adjust teaching and learning while they are happening. In this sense, formative assessment informs both teachers and students about student understanding at a point when timely adjustments can be made.”
Inquiry-based Learning

“Inquiry-based learning in science means that students develop understanding through using mental and physical skills to gather evidence about the natural and made world.”


Mechanics Baseline Test

“We have designed a test to assess student understanding of the most basic concepts in mechanics. The test is universal in the sense that it is limited to concepts that should be addressed in introductory physics at any level from high school through Harvard University.”


Peer-led Team Learning

“Under the Peer-led Team Learning (PLTL) model, undergraduate students who have done well in the class previously are recruited and trained as workshop leaders or peer leaders who guide the efforts of a group of six to eight students. These peer-led groups meet weekly (separate from the lecture and the instructor) to work together on problems that are carefully structured to help the students build conceptual understanding and problem-solving skills.”


Problem-based Learning

“Problem-based Learning (PBL) is an instructional (and curricular) learner-centered approach that empowers learners to conduct research, integrate theory and practice, and apply knowledge and skills to develop a viable solution to a defined problem.”


Progress-oriented Guided Inquiry Learning

“Progress-oriented Guided Inquiry Learning (POGIL) uses guided inquiry – a learning cycle of exploration, concept invention and application is the basis for many of the carefully designed materials that students use to guide them to construct new knowledge. POGIL is a student-centered strategy; students work in small groups with individual roles to ensure that all students are fully engaged in the learning process.”

Project-based Learning

“In Project Based Learning (PBL), students go through an extended process of inquiry in response to a complex question, problem, or challenge. While allowing for some degree of student ‘voice and choice,’ rigorous projects are carefully planned, managed, and assessed to help students learn key academic content, practice 21st Century Skills (such as collaboration, communication & critical thinking), and create high-quality, authentic products & presentations.”


Quality Matters

“The Quality Matters Rubric is a set of 8 general standards and 41 specific standards used to evaluate the design of online and blended courses. The Rubric is complete with annotations that explain the application of the standards and the relationship among them. A scoring system and set of online tools facilitate the evaluation by a team of reviewers.”


Science Teaching Efficacy Belief Instrument- Pre-service

“Riggs and Enochs (1990) developed a science teaching self-efficacy instrument for pre-service teachers. This instrument measures both of Bandura’s constructs of efficacy: self-efficacy or individuals’ ‘judgments of their capabilities to organize and execute courses of action required to attain designated types of performances” and outcome expectancy or individuals’ judgments or beliefs regarding the contingency between a person’s behavior and the anticipated outcome’”


Summative Assessment

“Summative assessment (‘Assessment of Learning’) is generally carried out at the end of a course or project. In an educational setting, summative assessments are typically used to assign students a course grade, and often a scaled grading system enabling the teacher to differentiate students will be used.”


Supplemental Instruction

“Supplemental Instruction (SI) is an academic assistance program that utilizes peer-assisted study sessions. SI sessions are regularly-scheduled, informal review sessions in which students compare notes, discuss readings, develop organizational tools, and predict test items. Students learn how to integrate course content and study skills while working together.”
