AC 2007-2467: A NEW HYBRID LABORATORY COURSE CHRISTENS A PIPELINE OF BIOLOGY STUDENTS FROM ALABAMA STATE UNIVERSITY TO THE UNIVERSITY OF SOUTH FLORIDA

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Abstract

The University of South Florida (USF) has partnered with Alabama State University (ASU), an HBCU institution, to initiate a new pipeline between the schools that has the potential to increase the number of ASU biology graduates enrolling in engineering graduate programs. This new pipeline will be christened by a new hybrid laboratory course in the spring of 2006 that exposes ASU students to the use of molecular biology based methods in engineering. This USF course was developed through an NSF-CCLI grant and offered to USF students in the spring of 2005. For the planned hybrid course, the lecture portion of the course will be broadcast live through the internet for ASU students. The lecture will be the responsibility of the USF faculty member, while the laboratory section will be provided locally to ASU students by an ASU faculty member. To prepare for this hybrid course, the USF hosted the ASU faculty member for a “crash course” on the laboratory techniques. With this model course in place, the USF College of Engineering faculty and ASU faculty partners will expand this pipeline by offering additional hybrid courses that share the biotechnology theme. With this pipeline in place, the USF and ASU faculty expect to expand this collaboration into a national model involving students from both institutions, and eventually additional students from other minority-serving institutions and community colleges.

Introduction

Based on the current trends and future needs of the United States, the National Science Foundation (NSF) has established goals to improve the research abilities and education of scientists and engineers. The NSF has identified the need for more engineers and scientists with training in the growing fields of nanotechnology and biotechnology. To facilitate this training, the NSF is pursuing two new research priority areas, “Nanoscale Science & Engineering” and “Biocomplexity in the Environment”, both of which offer opportunities to advance our scientific knowledge base through discovery.

The demand for more engineers in the United States is expected to increase by 9.4% from 2000 to 2010. Over the next two decades, massive retirements will further increase this demand. For 2002, a survey of undergraduate students enrolled in an engineering program found that 18.4% were female, 6.6% were African-American, and 8.4% Hispanic, which are below the 2001 populations levels for 18-24 years old (14.0% African-American and 17.4% Hispanic). By 2050, the percentage of Americans between 18-24 years old is expected to remain at 14% for African-Americans, but the percentage of Hispanics is expected to increase to 30%. These demographic figures and projections suggest that this demand for engineers can be met by a using a comprehensive strategy that increases the number of engineers coming from three large, historically underrepresented groups: females, African-Americans, and Hispanics.
The level of science and mathematics education for K-12 students in the United States is dropping compared to other developed countries\(^4\). Coupled with the recent explosion of discoveries in the sciences, a renewed and sustained effort at improving the science and engineering education in the United States is imperative. In addition, the demand for engineers in the United States as mentioned earlier is expected to increase by 9.4% from 2000 to 2010\(^4\). The next two decades will see further increase this demand due to massive retirements.

Demographic projections suggest that this demand will only be met by increasing the number of engineers coming from three large, historically underrepresented groups: females, African-Americans, and Hispanics. Based on the current trends in science education and future demands for engineers and scientists in the United States, the NSF has established two goals: (1) improve the education and research abilities of engineers and scientists; and (2) increase the number of engineers and scientists by expanding outreach activities that target students from historically, underrepresented groups\(^5\).

Most compelling, Environmental Engineering is one of the fastest growing careers with an expected increase of 54% by 2012\(^6\). Environmental engineering relies heavily on properly trained students in biotechnology, which includes an understanding of basic microbiology, biological modeling, and molecular biology. The development of molecular biology tools over the past twenty years has improved our understanding biological reactor systems\(^7\). This tool development will continue and it is imperative that environmental engineering undergraduate and graduate students learn how to use these tools properly. Some efforts have been recently made to provide an innovative course to undergraduate engineering students that have not completed coursework in Biology\(^1\). In addition, the expansion and refinement of our basic understanding of microbiology as it pertains to environmental engineering needs to be taught to younger students in K-12. As a priority, the NSF has identified the need for more engineers and scientists with training in the interdisciplinary areas of nanotechnology and biotechnology. To facilitate this training, the NSF is pursuing two new research priority areas, “Nanoscale Science & Engineering” and “Biocomplexity in the Environment”, both of which offer opportunities to advance our scientific knowledge base through discovery. To achieve both NSF goals, a comprehensive strategy is needed that includes the increase and improvement of educational, recruiting, and retention activities by universities, university faculty, and engineering societies.

The NSF has encouraged university faculty to expose students of all levels to their research and in some cases, allow active participation. Alabama State University (ASU) and the University of South Florida (USF) share the vision of the NSF and have been making strides in fulfilling NSF’s goals.

Foremost, this project’s goal is to design and implement enhanced inquiry-based learning and hands-on molecular based methods relevant to engineering that will expose minority science students to engineering concepts and practices. Alabama State University (ASU) represents an ideal model system because of the concentrated population of under-prepared minority students enrolled here, and the demonstrated weaknesses in science and engineering education exposure among that population of students. It is very crucial that we incorporate learning activities, which are novel and stimulatory in nature, in order to keep such students interested and helps them learn about areas of study that they may not have easily gravitate towards. The proposed application of computer technology and molecular based techniques in engineering are critical to
allowing execution and measurement of our objectives. A recent survey of ASU biology faculty reflected a need for the development of novel instructional approaches to stimulate student learning in the sciences, computer technology as a pivotal factor, and an overwhelming willingness to incorporate computer-based instruction into their existing strategies. Introductory students’ career choices are very malleable at this juncture in their academic development. Thus, a secondary goal of this project is to encourage an increased flow of underrepresented ethnic minorities, including females, into scientific careers such as engineering, thereby developing a new pipeline for retaining and attracting minority students to the field of engineering and other related disciplines.

Indeed, this project is narrowly focused and aspires to introduce a new, exciting, and highly effective dimension in science and engineering instruction for biology and other STEM majors from underrepresented groups, and to contribute towards finding a solution at the most fundamental level for increasing the participation of this nation’s minority populations in the advancement of science and engineering.

Alabama State University

Alabama State University is a historically black, publicly supported; coeducational institution located in Montgomery, Alabama, the state’s capitol. The school was founded in 1867 as Lincoln Normal School for Negroes in Marion, Alabama, and then moved to Montgomery in 1887. Accreditation was first granted by the Southern Association of Colleges and Schools in 1966 and in 1969 the State Board of Education elevated the college to University status and changed its name to the Alabama State University.

More than a century of vision, dedication, and struggle against all odds has brought ASU to its present stature. Today ASU occupies a 113-acre campus with 38 buildings, enrolls approximately 6,500 students. There are 800 faculty and staff members, 45 of them are science faculty, 40 with Ph.D. degrees. The school operates on the semester system and each faculty is required to teach a minimum of 12 credit hours per semester.

The student population is comprised of about 90% African-Americans and the remaining are white Americans, Hispanics, and Asians. The male to female ratio is about 40% to 60%. A majority of the students enrolled at ASU have a weak background in science, mathematics, engineering, and technology. Thus, the school represents a significant population of under prepared and disadvantaged minority students. ASU is dedicated to enrolling students of diverse needs and backgrounds, and its mission centers around providing curricula, instruction and research designed to prepare these students for the increasing opportunities available to them in the contemporary world.

ASU is organized into six colleges and schools: The College of Arts and Sciences, the College of Business Administration, the College of Education, University College, the School of Graduate Studies and Continuing Education, the School of Allied Health, and the School of Music. The degrees offered are the Associate of Arts, Bachelor of Science, Bachelor of Arts, Bachelor of Social Work, Master of Education, Master of Arts, Master of Science, Education Specialist, Doctorate of Educational Leadership, Law and Public Policy, and Doctorate of Physical
Therapy. The University’s degree offerings are complemented by an extensive core curriculum, freshman honors program, Biomedical Research and Training Program, Air Force Reserve Officers’ Training Corps (AFROTC), and dual degree programs with the state’s two flagship universities, Auburn University and the University of Alabama at Birmingham.

University of South Florida

The USF College of Engineering is well positioned to support the activities identified in this proposal. Established in 1964, the College has hired thirty new Engineering faculty in the past five years with an emphasis on biotechnology. In addition, significant human and financial resources have been invested into outreach and research training programs (CoE Research Experiences for Undergraduates, NSF IGERT, NSF LSAMP Bridge to the Doctorate, Sloan Ph.D. Programs) that have increased the enrollment of undergraduate students and graduate students from underrepresented groups in these nationally emergent STEM areas of study. Since Fall 2004, over forty new Black and Hispanic/Latino student have been recruited to work with faculty researchers in these respective areas within the College. Moreover, the College has initiated a 3+2 Cooperative Dual Degree Agreement with Bethune Cookman College (BCC), a historically black college in Daytona Beach, FL, where students may attend Bethune Cookman College for 3 academic years and the USF College of Engineering for two academic years. Upon completion of the academic requirements of both institutions, a student will be awarded a bachelor’s in mathematics from Bethune Cookman College and a bachelor’s in civil, chemical, electrical, industrial or mechanical engineering from USF. Of particular relevance for students from minority-serving institutions (e.g. Alabama State University) lacking engineering programs is that USF’s College of Engineering offers interdisciplinary-oriented masters and doctoral programs in engineering sciences for students with non-engineering baccalaureate degrees.

Status of Existing Programs at ASU

ASU is committed to providing quality education and training for its students. As a part of that commitment, a Quality Control Program was implemented in 1985 with the support of the Department of Education’s Title III grant. This University-wide system of academic accountability was designed to increase and assure the achievement of expected educational outcomes within each discipline and to promote the continued improvement of academic program quality. The Program’s objectives are met by: (1) regularly monitoring instruction in various courses in order to assure well-prepared syllabi, consistency between course objectives and testing materials, and effective classroom instruction, and (2) regularly monitoring student performance on national standardized tests and utilizing the test results in a feedback manner to improve instruction and learning across the curricula. Hence, the instruction and assessment methods in the science courses to be affected by this proposal are designed to further enhance the current HBCU-UP program at ASU and to serve as a pipeline for attracting minorities to the field of engineering.

ASU has established goals for the science disciplines, which encompass rigorous academic standards for training. Inadequate student preparation levels notwithstanding, these very high standards have been set because it has been realized that students must emerge from ASU fully qualified and fully competitive for admission into post-graduate, professional school and
employment sectors. To this end, efforts to enhance science education at ASU have been fostered mainly by: (1) consistently seeking external resources to supplement existing internal resources and (2) developing linkages with major universities in an effort to increase the number of disadvantaged and underrepresented minorities who pursue advanced degrees in all disciplines, especially the sciences and engineering fields. Student enrollment at ASU has increased during recent years, increasing from 5,490 in 2002 to approximately 6,500 in 2005 with biology having the largest numbers of declared majors (Table 1). This increase over the last 10 years is due to: an increased commitment of resources for expanding remedial programs in core requirements (e.g., mathematics and science, reading, and writing), an added emphasis on improving the quality of education and training provided to the students such as the Quality Control Program, an expanded staff for recruitment, retention, and tutoring and counseling of students.

Table 1: ASU Enrollment in STEM Degree Programs 2002-2005

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<thead>
<tr>
<th></th>
<th>Fall 2002</th>
<th>Fall 2003</th>
<th>Fall 2004</th>
<th>Fall 2005</th>
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<tbody>
<tr>
<td>Total Student Enrollment</td>
<td>5,274</td>
<td>5,553</td>
<td>5,666</td>
<td>5,969</td>
</tr>
<tr>
<td>Biology</td>
<td>252</td>
<td>281</td>
<td>334</td>
<td>351</td>
</tr>
<tr>
<td>Mathematics</td>
<td>42</td>
<td>45</td>
<td>58</td>
<td>55</td>
</tr>
<tr>
<td>Chemistry</td>
<td>19</td>
<td>22</td>
<td>17</td>
<td>13</td>
</tr>
<tr>
<td>Health Information Management</td>
<td>41</td>
<td>47</td>
<td>43</td>
<td>49</td>
</tr>
<tr>
<td>Occupational Therapy</td>
<td>138</td>
<td>159</td>
<td>104</td>
<td>61</td>
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</tbody>
</table>

The University College is the college of entry for all undergraduates enrolling at ASU before they enter the various degree-granting colleges. The science majors enter the College of Arts and Sciences after satisfactory completion of the core requirement. The Department of Biological Sciences is one of the departments within the College of Arts and Sciences and has 10 full-time faculty and staff members to teach students the basic tenets of biological sciences. The Department offers both undergraduate and graduate programs. More recently, the State has approved a new doctoral program in Microbiology which will commence in the fall 2007. The following courses offered by the Department of Biological Sciences will be affected by this proposal: Botany, Zoology, Microbiology, Molecular Biology and Genetics, Cell Biology, and Ecology. The proposed course will introduce undergraduate students to the theory and use of molecular biology based methods for the investigation of natural and engineered systems. It is designed to provide excellent experience that will stimulate undergraduate students to pursue careers in engineering, a STEM discipline. This proposal will implement new inquiry-based investigations to improve students’ understanding of the scientific method. It is also designed to strengthen the current STEM program at ASU.

Institutional Need

It has been frequently noted in the media and education literature that the nation’s student performance in science, mathematics, and engineering has declined compared to other advanced countries, due in part to passive teaching styles, and the ineffective or infrequent use of visual aids and instructional media coupled with the lack or infrequent use of hands-on laboratory activities. To address this problem, learning activities must be adopted to include ample
exercises, which focus on active student participation and critical thought processing. These experiences must provide an approach to problem solving, which is the hallmark of engineering and biological studies. Our biology courses are designed to provide an understanding of the basic phenomena and principles in biology. None of our biological science courses are designed to propel students toward engineering. The introduction of this course will serve as the first model course that will not only help develop critical thinking skills of our science majors but will stimulate them towards careers in engineering. Moreover, this project will provide state of the art technology and hands-on activities that will stimulate analytical and critical thinking skills in our students. Underdeveloped critical thinking skills are a major disadvantage that entering students at Alabama State University exhibit on a broad scale. Such a population of students can become lost and disinterested when forced to process complex motion-change concepts without adequate simulation to reinforce dynamic biological mechanisms. With the implementation of high tech multimedia course infused with hands-on laboratory components such as the one being proposed, these concepts can be vividly illustrated, demonstrated and even converted from one-way to two-way information flow. For example, online instructional module on protein synthesis could be utilized that would allow the students to make up random gene mutations. The resulting mutant phenotypes generated would become a function of the students' own creativity and thus enforce the concept of mutability in a novel manner. Moreover, the students will be given the power to learn from home or school or anywhere at anytime.

Visual displays in instruction have become a primary component of media based-instruction. When the learning process involves visual displays along with verbal communication and hands-on activities, information is retained longer in memory and is more easily accessed. The interactive graphic application is the best example of this instructional paradigm, which is very fruitful in biology instruction. Graphic animation has been used to explicitly represent invisible flow of information.

A recent survey conducted in our General Biology classes (with a majority of African-American women) has shown that students feel very strongly about using multimedia and hands-on activities to reinforce topics learned in the classroom. Students in these kinds of courses need stimulatory experiences to firmly grasp the complex and dynamic molecular and physiological mechanisms taught in modern biology courses. Interactive computer graphics have the greatest effect on instruction, since students actively participate in the learning process. The current state of instruction in which passive learning is dominant, needs to be redesigned to actively involve students in the process of learning. With the introduction of multimedia technology in contemporary science education, it is possible to present and review instructional material in ways that have otherwise been impossible. Genomics is redefining the frontiers of basic, fundamental, and applied biological science. Advances in genomic-enabled technology are exploding-breaking through traditional disciplinary boundaries and permeating many fields including science and engineering. The integration of quantitative, analytical tools from molecular sciences with innovative bioreactor design and operation has been the corner stone for the future of the field of science and environmental engineering. It was reported not long ago that analytical tools in molecular biological sciences was identified as one of four critical research needs in the field of Environmental Engineering. There are currently no courses within the department of Biological Sciences or any other department for that matter that serve as pipeline for attracting students to engineering. Therefore there is a need to offer a course to
actively involve students in the process of learning that will expose them to the field of engineering and motivate them to pursue alternative career paths. Data from various sources indicate that few minority biology students eventually pursue graduate programs in biology or similar programs. The numbers of Alabama State University biology students and other STEM majors enrolling in graduate programs are even smaller (Table 2).

Table 2. Graduation School Enrollment Rates of ASU students

<table>
<thead>
<tr>
<th>% of students who enter graduate programs</th>
<th>&lt;5%</th>
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<tbody>
<tr>
<td>% of students with biology majors who enter graduate programs</td>
<td>7%</td>
</tr>
<tr>
<td>% of students who earned engineering degrees</td>
<td>0%</td>
</tr>
<tr>
<td>% of students with biology degrees who earned engineering graduate degrees</td>
<td>0%</td>
</tr>
</tbody>
</table>

With the introduction of the “Molecular Technique in Engineering” course, it is possible to create a model course that will serve as a key component of a comprehensive national strategy for recruiting and retaining non-engineering students from minority serving institutions into graduate engineering and science research programs.

Measurable Goals and Objectives

This project represents an exciting opportunity to build upon current ASU activities, while simultaneously leveraging the resources available at the USF College of Engineering. The measurable objectives of the project are described herein:

**Measurable Objective 1:** To enroll 10 junior-level biology and students from other STEM majors per year in the lecture and laboratory sections of the “Molecular Techniques for Engineers” course.

*Measure:* Finalized class rolls with student information (name, social security number, and academic major)

**Measurable Objective 2:** To increase by 10% per year the number of biology and other STEM majors successfully enrolling in engineering graduate programs and closely related programs each year.

*Measure:* Documented number of graduate school applications to engineering and closely related programs (mathematics, environmental science, marine science, etc.). Mr. Batson will assist with the graduate school applications and facilitate workshops at Alabama State University on “Graduate admissions in engineering and biotechnology programs.”

**Measurable Objective 3:** To assist students in defining their career goals, motivation for graduate study or careers within industry and research interests via “mentoring” relationships with USF faculty and graduate students

*Measure:* Students will be expected to attend HBCU-UP graduate school awareness workshops hosted by USF graduate students at ASU.

**Measurable Objective 4:** To provide students with enhanced preparation by providing laboratory-based skills for entry into the professional workforce or graduate programs in environmental science/engineering.
**Measure:** Documented number of student internships in industry and in governmental labs. During his campus visits to Alabama State University, Mr. Bernard Batson will meet with students and facilitate their participation in summer internships in industry and governmental labs.

**Proposed Activities**

It is evident from various studies that active learning experiences through the use of appropriate instructional technology can serve as a stimulus to attract students to any specific field including engineering. Therefore, the program will be structured to meet the following objectives:

1) To teach how scientists and environmental engineers use molecular biology based methods as research tools. This will be accomplished by three mechanisms:

   a. **Fundamental discussion of molecular biology skills.** Introductory materials will be expanded to include thirty percent of the total course (5 of 15 lectures, see course syllabus) in order to help clarify the objectives of the course as well as to establish a familiarity with the molecular biology terminology and skills necessary for the laboratory. Formal lectures will be conducted by the USF faculty member once a week via video conferencing from the campus of the University of South Florida. Introducing computer-based technology to disadvantaged students will increase their interest in learning and use of technology.

   b. **Emphasizing case studies and discussing the application of molecular biology tools to address engineering problems.** This is critical because introducing students to engineering case studies as part of the course will demonstrate to the students the value of using molecular biology tools to address engineering problems in water treatment, wastewater treatment, and bioremediation. Also, the course will include a discussion of practical applications as an efficient approach to bridge the students’ molecular biology background with engineering process. This will help students understand how technology can be used to solve ‘real’ engineering problems.

   c. **Team-teaching by combining the expertise of two instructors.** This course will be team-taught by two instructors with complementary expertise (Environmental Engineering faculty member at USF and Environmental Microbiology faculty member at ASU). With rich experience in each field, students will benefit from two different perspectives of the application of Molecular Biology in Environmental Engineering. Moreover, the ASU faculty member will direct the laboratory component while the USF faculty member directs the lecture component.

2) To use various molecular biology based methods to investigate samples from natural and engineered systems. This will be accomplished by introducing new laboratory exercises such as fluorescence *in situ* hybridization (FISH), DNA and RNA extraction, polymerase chain reaction (PCR), reverse transcription and primer extension (RT&PE), and high throughput genomic analysis by capillary electrophoresis. The laboratory component will be carried out on the campus of Alabama State University. The students will meet twice a week for laboratory activities. The laboratory procedures developed at the University of Cincinnati will be used
Based upon student assessment and feedback, adjustments will be made to the course content to adapt the materials as appropriate for the students’ learning level at Alabama State University. At ASU the students participating in the program will initially be recruited from the current NSF HBCU-UP program. The initial cohort will consist of ten students. They will be divided into several groups of two students each to conduct all of the laboratory exercises (i.e., DNA extraction from environmental samples and fluorescence microscopy). At the end of the course, each group will present their results in an oral report and submit a comprehensive written lab report. A team approach is expected to provide students with a strong demonstration of the fundamental and practical perspective of Molecular Biology applied to Environmental Engineering. Upon approval of the course (currently in review) by the Curriculum Review Committee and the College of Arts and Sciences, then it will be opened to the rest of the university student population.

Strategies for Program Implementation

The ASU Department of Biological Sciences in collaboration with the USF seeks funding to establish a rigorous program that will expose undergraduate biology students to engineering opportunities. Since this course is focused on undergraduate biology students with limited or no exposure to environmental engineering, course materials selected will include review and discussion of primary literature implementing biomolecular tools for engineering applications. The initial cohort will consist of 10 students divided into groups of two students each. With the assistance of the instructor, each student group will select and present one article to the class. Presentation of the article will be followed by group discussion. Also students will be required to keep a journal of their thoughts and reflections on the reading and lecture material. Support material from initial teaching of this course is posted on the course homepage: www.engr.colstate.edu/ce/homepages/pruden/classes/ce58/ce581/index.shtml. This course was original developed at the University of Cincinnati and has been taught in schools with engineering programs. The model for ASU is new since this is the first time a course like this has been developed for teaching in an HBCU with no engineering program. The proposed course “Molecular Technique in Engineering” is designed to enhance inquiry-based learning. Therefore student teams will select from among several samples representing different bioprocesses use in wastewater treatment (i.e., primary solids, activated sludge, anaerobic sludge). The students will conduct literature review and apply molecular biology tools to investigate their samples. Each student group will provide a final report and presentation of their findings to the class. Each student will be able to access ready-made, proven science instruction that is available 24 hours a day, 7 days a week from any computer that has access to the Internet. Lecture sessions will involve interactive learning exercises that conform to course content and objectives outlined in the standard non-computer based course syllabi. For whole-class activities, instructors will present the electronic notes on a larger projection screen and explain each concept with the help of software programs. The file server terminal will be capable of monitoring and programming each terminal as necessary, introducing the capability of assigning students to team-oriented activities, individual evaluation, etc. The students will be involved in every step of the learning process. There will be models, figures, and questions that students will work on using their computers. The use of electronic notes provides the following advantages to the students over existing methods of instruction: 1) it makes lectures interesting, 2) it supports the content of the course well, 3) it is easy to see and read, 4) it helps to clarify information, 5) it
helps to hold attention and increase retention, 6) it improves the organization of the lecture, 7) it helps students to take notes, and 8) it is easy to make up missed classes since the material is always available on the web, and 9) increases group discussion among colleagues and 10) web literacy is enforced.

Similarly, electronic notes provide advantages to the instructors over the existing method of teaching: 1) preparation time is reduced once the electronic notes are ready, 2) complex processes are easy to explain with graphics, 3) the notes are easy to modify or change, 4) it is easy to test students and keep their records, 5) facilitates the access to current literature via internet, 6) it is easier to network with other faculty members, and 7) increased computer literacy is supported.

Course Related Activities

The “Molecular Technique in Engineering” course developed by this project will be identified in the school’s schedule. Students will be advised before enrolling for the course. We will provide relevant information to the University’s Advisement Center for proper advisement. All lectures will be taught in the electronic lecture format via video conference from the University of South Florida. This course will be designated at ASU as BIO 351 “Molecular Technique in Engineering”. It will focus on integrating molecular techniques in engineering processes.

Laboratory sections of BIO 351 will be taught in the newly modeled microbiology teaching laboratory designed to hold maximum of 24 students. The primary exercises in the laboratory will involve identification, enumeration, location, and measurement of growth activities of microbial populations. It will also entail analysis of data, development of written laboratory reports, and evaluation methods similar to standard laboratory format. Laboratory activities will conform to Quality Control standards. During the summer semester, the teaching activities will be reduced to half and the time saved will be utilized to develop more instructional material, evaluate new software, analyze student feedback and make desirable changes to the instructional material. We anticipate that about 10 students per semester will be served through this project. A total of about 30 students will be affected each year including the summer semester.

Implementation of the Electronic Notes in the Classroom

The first class in the course will be about operation of the equipment. Students will be provided with course syllabi, which will include detailed instructions for operating all equipment, and will be encouraged to attend extra hour sessions on the operation of multimedia equipment. Each subsequent subject matter lesson will consist of text, graphics, computer simulations, real life laboratory exercises, pictures, etc. and will be described within the course syllabus. The lecture notes will employ hypertext and hypermedia frequently to increase the learning ability of the students and keep them interested at the same time. The lectures will also feature question and answer sessions during the class hour. In the first five minutes of the class, students will enter their student number for attendance purposes and take a quick test (pre-lecture test) from the previous lessons. Instructors will link the previous lesson’s importance to the current lesson. At the end of the class, a summary of the lesson will be provided. Whenever necessary, students
will be given handouts, copies of the colored pictures and any other material necessary to support the learning process. Students will be tested on the computer using a test bank developed for each course in accordance with Quality Control guidelines. The inherent flexibility of the computer-based classroom format will provide opportunities to evaluate each student with a different question format, though with the same level of difficulty as other students. The test scores of each student will be displayed on the screen with their student numbers. The testing periods will be thirty minutes, except for the final examination, which will be one hour. There will be a total of four tests including the final examination. The pre-lecture tests, classroom assignments, presentations and other activities will equal to one full test. The review questions will be available to the students after class to practice for the test. The schedule for the electronic lecture room will be posted clearly on the door to provide the hours of operation.

**Identification of Problems and their Possible Solutions**

It is expected that in the beginning there may be some problems with running programs and presenting the material to the class. Some of the lessons may also contain some mistakes or flaws. To overcome this, the problems encountered will be resolved immediately. If there is any technical problem, the school’s computer support services will be called upon to rectify the problem or suggest manufacturer intervention if necessary. The program advisor will make at least two visits to ASU campus to ensure efficient operation of the facility and progress of the program. The electronic lecture notes will be corrected and modified as necessary. Student comments will be given due consideration in the process of modification.

**Regular and Extra Hour Support**

The video conferencing classroom schedule will be posted on the door for information and the room will be available during posted hours. The room will be available to the students every day (M-F) for two and one-half hours in the evening. The room will be available to faculty during the posted hours. The faculty will meet during this period to discuss the program, make changes in the instructional material, and discuss the problems and possible solutions. All meetings related to this project will be held during this period in the electronic classroom. During the regular hours the Program Staff will be available. All faculty members will provide extra time when requested by the students and will be incorporated into each faculty member’s required office hours.

**Introduction of Other Courses in Similar Setting**

During the latter stage of the project period the electronic classroom will be made available to one other discipline to use the same technology for teaching other courses. This will be done as a preliminary evaluation of the interdisciplinary application of a non-traditional instructional approach at Alabama State University based upon an electronic classroom format. The electronic lecture room model will be presented to the University’s Multimedia Committee for their recommendation to other departments and colleges. Information will be available on the Internet for possible use by other interested schools/colleges.

**Plan for Continuation**
The USF administration is strongly committed to this program. Future support of the project will be pursued through funding opportunities offered by NSF. After the first two years, the advisory committee will evaluate the project regarding its potential to be permanently phased into the infrastructure of the University. The electronic lecture room model will be presented to the University’s Multimedia Committee for their recommendations as to the possible impact of the project in teaching other courses. The Project Director, Department Chair, the Dean of the College of Arts and Sciences, the Vice President for Academic Affairs and the Vice President for Fiscal Affairs will convene at the end of the second year to develop a plan for continuation of the program. The plan will be presented to the University President who will institute it in increments over the years, thereby effecting the complete institutionalization of the program at ASU in collaboration with USF. This project will have a great impact on biology education and is favored by both the Vice-President for Academic Affairs and the President.

Project Management and Evaluation

The program will be a part of the Department of Biological Sciences. The Project Director will be responsible for the overall monitoring and evaluation of the program. The Program Associates (USF faculty member and USF project senior advisor) will administer the evaluative instruments, gather and analyze the data, and assist in this task. The Project Director will report to the Chair of the Department and Dean on academic matters and the Vice President for Fiscal Affairs on fiscal matters. The Program Associates and other faculty (when added) will report to the Project Director.

The Project Director is the ASU faculty member who holds a Ph.D. degree in environmental microbiology with a minor in toxicology. He has nine years of experience in teaching and mentoring disadvantaged minority students and an extensive research background. He has recently attended several workshops on teaching methodologies in the sciences. He also has experience with microcomputers, including graphics design and internet information retrieval. As Project Director, he will teach this course as part of his spring semester class load.

The USF faculty member holds a Ph.D. degree in environmental engineering. He has three years of experience teaching at a research intensive institution. He is currently Assistant Professor in the Department of Civil and Environmental Engineering, and Co-Director of the Florida Center of Excellence for Biomolecular Identification and Targeted Therapeutics at the University of South Florida. The Center is a new $8 million state-funded initiative designed to stimulate the growth in the biotechnology industry in Florida by developing and translating new technologies into commercial products which benefit the environment and public health. His area of research blends traditional engineering design, microbiology, and molecular biology. He uses molecular biology tools to determine the abundance and growth activity of distinct microbial populations in bioreactors. Over the past seven years, he has used membrane hybridizations, fluorescence in situ hybridizations (FISH), FISH combined with microautoradiography (FISH-MAR), and terminal-restriction fragment length polymorphisms (T-RFLP) to investigate various aspects of biological reactor systems. Recently, he invented and developed the RiboSyn method that measures the specific growth rate of a distinct microbial population in a mixed culture. This new
method has been integrated into the new “Molecular Biology for Engineers” course offered at the USF.

Each of the participating faculty in the program have extensive experience in teaching and motivating college students, and have a deep commitment to working with disadvantaged minority students. The USF faculty member is the research advisor for two NSF Bridge to the Doctorate and Alfred P. Sloan Minority Ph.D. students (1 Hispanic female, 1 African American female), formerly served as advisor for 1 minority masters student (Hispanic female), and has mentored minority undergraduates in his research group. Additionally, he has sought to make diverse students aware of the benefits of graduate education through his participation at national research conferences for underrepresented students. Through these activities, he has encouraged underrepresented students from non-engineering backgrounds to pursue graduate programs in engineering and biotechnology. In fact, both of his minority doctoral students (Andrea Rocha and Kathryn Bailey) earned biology undergraduate degrees from minority-serving institutions and are now enrolled in the Ph.D. program in Engineering Sciences at USF. As a team, both faculty members can correlate very well with their students’ needs. The faculty members are ready and anxious to commence this new “Molecular Technique in Engineering” course.

The USF Project Senior Advisor has experience in higher education in the implementation of student peer mentoring programs, fellowship application workshops, retention programs, and the graduate school admissions process for students from underrepresented groups. He is the Program Manager of the NSF IGERT, NSF Bridge to the Doctorate, and Alfred P. Sloan Minority Ph.D. Programs at USF. Since Fall 2004, he has recruited over seventy Black and Hispanic graduate students in STEM areas of study to USF, and mentored them with fellowship and internship opportunities. He will help to facilitate internship and graduate school admissions placements for students enrolled in the course, and coordinated collaborative visitations of USF faculty and minority graduate students to Alabama State University.

**Evaluation**

The Project team will implement an outcomes-based assessment strategy to determine: project’s strengths and opportunities for improvement; participants’ outcomes; and effectiveness of Project’s activities and overall achievement of goals and objectives in the different major tasks (e.g., education, research). The strategy will consider the fact that conditions change, better ways of doing things emerge, and new players with new ideas join the team. The fundamental elements of the assessment strategy are: internal/self assessments, external assessments (outside the Project), use of multiple criteria, holistic perspective, and quantitative and qualitative components. Assessment strategies include:

- study Project goals and objectives, expected outcomes and performance indicators/metrics based on the strategic plan
- develop specific criteria for each metric
- develop assessment and data collection methods
- establish assessment schedule
- conduct assessments
- analyze data
- report to constituents/stakeholders
• revise strategy, improve and continue

The primary means of assessment will be through survey and interview data, both from students and instructional personnel. Formative assessment and communication with the ASU and USF faculty members will be ongoing to ensure that each faculty member is able to make adjustments in a timely fashion, both in regards to course delivery and evaluation processes. Summative assessment will be conducted on an annual basis through provision of a written report.

The assessment will be led by the Director of CREAM (Center for Research, Evaluation, Assessment and Measurement) in the USF’s College of Education’s Department of Educational Measurement. Her interests include theoretical and methodological research as well as applied statistics. She is an expert in the field of programmatic assessments and has conducted numerous assessment and evaluations for other NSF grants in the College of Engineering, including the Research Experiences for Teachers and Research Experiences for Undergraduates programs.

**Broader Impact**

The implementation of this project will have a significant effect on the students. Their interest, learning ability and understanding of molecular biology and engineering is expected to increase. As a result of funding through the NSF-CCLI A&I program (Award # 0511107), similar courses have been introduced at Colorado State University, Pennsylvania State University – Harrisburg, University of Wisconsin – Milwaukee, University of Cincinnati, University of Connecticut, and the USF. At these universities students’ learning and interest in the engineering has increased tremendously. We anticipate comparable results at ASU. In terms of the understanding of the subject, it is expected that the majority of the students will also improve their grades in biology courses, and because of sound conceptual understanding, biology majors will subsequently perform better. The success of this project will eventually promote the establishment of other such models in other universities. Thus, student learning in other subjects like mathematics, physics, and chemistry will also increase.

It is expected that a large number of biology students will be directly affected in the two years project period. At least 10% (100) of these students may be influenced to pursue a higher education in one of the areas of engineering. One of the successes of this program will be evident when students participating in this project choose engineering or other related sciences for their career. We expect that in the long term some program participants at ASU will eventually be admitted to graduate schools, and other programs in the sciences/engineering. These figures will be tracked long-range through the Office of Alumni Affairs, and comparative statistics will be initiated five years following the implementation of the project.

**BIBLIOGRAPHY**


5. *National Science Foundation Strategic Plan 2003-2008*, N.S. Foundation, Editor. 2003, National Science Foundation, p. 34.


