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About the Poster Abstracts and Poster Sessions

About the American Association for the Advancement of Science (AAAS)

Poster Abstracts (Alphabetized by Institution within Categories)

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   A1: Encouraging and Enabling Student Active Learning (Examples include Case Studies, POGIL, Clickers, Problem Based Learning)
   A2: Enhancing student learning through use of biological technologies (Microscopy and other visualization techniques, mass spectrometry, microarrays)
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   A4: Student Research introduced as an Integral Part of Traditional Courses and Introduction of Technologies New to Biology
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B. What is Taught: Concepts and Competencies and Assessing Outcomes
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Additional Poster Abstracts

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ABOUT THE POSTER ABSTRACTS AND POSTER SESSIONS

The goal of the *Transforming Undergraduate Education in Biology: Mobilizing the Community for Change* conference is to mobilize people to focus on undergraduate biology education by engaging them in shared, directed, provocative, and ongoing discussions that lead to action in the immediate future. Towards this end, poster abstracts highlight new and existing approaches, projects, and resources for effecting change in undergraduate education in biology, including departmental and institutional change efforts.

The poster session is viewed as a way to network and find out what others are doing and to make connections with others based on disciplinary and cross-disciplinary interests and on their approaches to changing undergraduate biology education. Most abstracts describe the:

Goals and intended outcomes of your project or effort.

Methods and strategies.

- Evaluation methods and results or evaluation plans.
- Dissemination activities or plans for dissemination.
- Impacts of your project or anticipated impacts.
- Unexpected challenges and methods for dealing with them.
ABOUT THE AMERICAN ASSOCIATION FOR THE ADVANCEMENT OF SCIENCE

The American Association for the Advancement of Science (AAAS) is the world’s largest general scientific society and publisher of the journals, *Science* (www.sciencemag.org) and *Science Signaling* (www.sciencesignaling.org). *Science Translational Medicine* (www.sciencetranslationalmedicine.org) will be published beginning in the fall 2009.

AAAS was founded in 1848, and serves 262 affiliated societies and academies of science, reaching 10 million individuals. *Science* has the largest paid circulation of any peer-reviewed general science journal in the world, with an estimated total readership of 1 million.

The nonprofit AAAS (www.aaas.org) is open to all and fulfills its mission to “advance science and serve society” through initiatives in science policy; international programs; science education; and more.

For the largest research news, log onto EurekAlert!, www.eurekalert.org, the premier science-news Web site, a service of AAAS.

AAAS has four primary program areas, including Education and Human Resources, International Activities, Project 2061, and Science Policy.

Visit the AAAS website at www.aaas.org.
**Poster #1**

**Category:** A1  
**Primary Project or Approach:** Encouraging and Enabling Student Active Learning (Examples include Case Studies, POGIL, Clickers, Problem Based Learning)  
**Institution:** American Museum of Natural History  
**Presenter:** Eleanor Sterling  
**Email:** sterling@amnh.org  
**Co-Presenter:** Nora Bynum, American Museum of Natural History  
Ana Luz Porzecanski, American Museum of Natural History  
Brian Weeks, American Museum of Natural History  
**Field of Interest within Biology:** Conservation Biology  

**Goals & Intended Outcome:** The American Museum of Natural History’s Center for Biodiversity and Conservation and its partners developed the Network of Conservation Educators and Practitioners (NCEP, http://ncep.amnh.org) to build the capacity of the individuals managing and sustaining the world’s biological and cultural diversity.

**Methods & Strategies:** NCEP develops and disseminates open educational resources (OERs), fosters an active approach to teaching and learning, and creates global opportunities for communication and interaction among conservation educators and practitioners.

**Evaluation Methods & Results:** Faculty members interviewed as part of the summative evaluation of the project indicated their positive impression of the project by confirming that they either had already recommended (71%) the modules to their colleagues, or would recommend them in the future (29%). In 2007-2008 faculty members from 11 institutions tested NCEP OERs and found significant gains in students’ content knowledge and other indices. Gains occurred irrespective of school, ethnicity, reasons for enrollment, student’s major, expected grade, or GPA.

**Dissemination Activities & Plans to Disseminate:** 50 authors from 30 institutions contributed to the development of the 25 modules and 8 case studies; 69 reviewers came from 35 institutions; 77 faculty members from 57 institutions tested modules. The NCEP website averages monthly 12,078 hits and 917 visits, with 4,415 module components downloaded. We also conducted two faculty development workshops over the course of this grant.

**Impacts of Project or Anticipated Impact:** A study by participating faculty found that students demonstrated significant gains in content knowledge after using exercises from NCEP modules. These gains were consistent across a range of classes taught at a diverse array of institutions. Students also reported increased confidence in their biodiversity related knowledge after completing courses with these materials. In addition, students’ attitudes shifted toward increased agreement with pro-environment statements after completing courses with these materials. The results of this study were presented in a poster at the 2008 ESA meetings (Palmer et al. 2008).

**Challenges:** We found that often the specialists in a field, either scientists or educators, did not have sufficient time to devote to developing and testing materials because their work on this project was initially not supported by their administrators. We restructured the benefits such that materials now come out in an on-line peer-reviewed educational journal - Lessons in Conservation - allowing for publishing credit to those who need it, and developed a faculty focus group that worked with us to evaluate the materials. Each member of the focus group received funding to attend an annual meeting of their choice to present the results.

**Abstract:** Resources for Teaching and Learning in Biodiversity Conservation: The Network of Conservation Educators and Practitioners (NCEP)
The American Museum of Natural History’s Center for Biodiversity and Conservation and its partners developed the Network of Conservation Educators and Practitioners (NCEP, http://ncep.amnh.org) to build the capacity of the individuals managing and sustaining the world’s biological and cultural diversity. A global initiative, NCEP develops and disseminates open educational resources (OERs), fosters an active approach to teaching and learning, and creates global opportunities for communication and interaction among conservation educators and practitioners. One of the project’s most important tangible products is a series of freely available multi-component OERs. At present, resources covering more than 59 topics are available for use and testing in four languages. In 2007-2008, a group of 12 faculty members from 11 institutions tested the efficacy of NCEP OERs. We found significant gains in students’ content knowledge, confidence in biodiversity conservation knowledge, and overall learning in biodiversity following exposure to three of our core biodiversity OERs. Gains occurred irrespective of school, ethnicity, reasons for enrollment, student’s major, expected grade, or GPA. We are committed to further research that benefits and guides teachers in classroom instruction in conservation biology, and further evaluation of our materials is planned for 2008-2009. Continued resource development is planned for the next 3-5 years, but NCEP is shifting its efforts toward faculty development. Since 2001, we have reached over 1,800 faculty members, practitioners, and students through more than 70 workshops and training events in 15 countries. Workshop development efforts focus on topics such as course design, integrating formative evaluation, and addressing student misconceptions.

Poster #2
Category: A1
Primary Project or Approach: Encouraging and Enabling Student Active Learning (Examples include Case Studies, POGIL, Clickers, Problem Based Learning)
Institution: Botanical Society of America
Presenter: Christopher Haufler
Email: vulgare@ku.edu
Co-Presenter: William Dahl, Botanical Society of America
Field of Interest within Biology: Plant Biology & Botany

Goals & Intended Outcome: Challenged by Bruce Alberts, then president of the US National Academies, to lead change in addressing poor performance by US Middle and High school students in math and science scores the Botanical Society of America (BSA) sought new ways to involve professional scientific societies in encouraging better scientific literacy among students.

Methods & Strategies: The basic model uses core concepts outlined by the National Research Council for enhancing science learning. It builds on evolving internet technologies to support professional scientific society members as mentors for Middle and High School research teams to develop authentic research questions and then answer those questions through hands-on experiments.

Evaluation Methods & Results: After successful proof of concept trials, PlantingScience obtained funding from Monsanto and the National Science Foundation to develop the program further, including specific teacher training in the use of online inquiry based educational concepts. By linking student groups with science mentors, learners are guided to discover how science works, and are mentored to use the scientific process to probe for answers to questions about how biological science makes progress. To date, 10 professional societies representing about 250,000 professional scientists are contributing to PlantingScience, and nearly 5,000 students from 76 different schools across 31 states have benefited from the program.

Dissemination Activities & Plans to Disseminate: We anticipate continuing to increase the number of students and professionals involved with PlantingScience and we intend to reach 10,000 students by 2011.
Impacts of Project or Anticipated Impact: PlantingScience, therefore, helps students discover the process of science, gives learners the opportunity to be involved with authentic scientific research, and involves graduate students in mentoring the next generation to become scientifically literate citizens.

Challenges: None.

Abstract: PlantingScience: Professional Societies Help to Grow New Generations of Researchers

Challenged by Bruce Alberts, then president of the US National Academies, to lead change in addressing poor performance by US Middle and High school students in math and science scores the Botanical Society of America (BSA) sought new ways to involve professional scientific societies in encouraging better scientific literacy among students. The basic model uses core concepts outlined by the National Research Council for enhancing science learning. It builds on evolving internet technologies to support professional scientific society members as mentors for Middle and High School research teams to develop authentic research questions and then answer those questions through hands-on experiments. After successful proof of concept trials, PlantingScience obtained funding from Monsanto and the National Science Foundation to develop the program further, including specific teacher training in the use of online inquiry based educational concepts. By linking student groups with science mentors, learners are guided to discover how science works, and are mentored to use the scientific process to probe for answers to questions about how biological science makes progress. To date, 10 professional societies representing about 250,000 professional scientists are contributing to PlantingScience, and nearly 5,000 students from 76 different schools across 31 states have benefited from the program. We anticipate continuing to increase the number of students and professionals involved with PlantingScience and we intend to reach 10,000 students by 2011. PlantingScience, therefore, helps students discover the process of science, gives learners the opportunity to be involved with authentic scientific research, and involves graduate students in mentoring the next generation to become scientifically literate citizens.

Poster #3
Category: A1
Primary Project or Approach: Encouraging and Enabling Student Active Learning (Examples include Case Studies, POGIL, Clickers, Problem Based Learning)
Institution: Brigham Young University
Presenter: Keith Crandall
Email: keith_crandall@byu.edu
Co-Presenter: Brian Woodfield, Brigham Young University
Riley Nelson, Brigham Young University
Field of Interest within Biology: General Biology

Goals & Intended Outcome: The Virtual Biology Lab (VBL) is a set of labs that offer students an open-ended, inquiry-based experience in biology without the cost and facilities needed for traditional biology lab experiences. The labs are targeted for junior high through college freshman college level (mainly high school biology and non-majors biology at the university level) to aid in bringing significant learning opportunities to students who would otherwise not be able to participate in a lab experience.

Methods & Strategies: The VBL consists of five core labs; 1) microscopy, 2) molecular biology, 3) genetics, 4) ecology, and 5) diversity. These labs are coupled with a database of more than 150 different species of organisms throughout biological diversity including many of model organisms (e.g., Drosophila melanogaster, Homo sapiens, Caenorhabditis elegans, Arabidopsis thaliana, and Escherichia coli).
Evaluation Methods & Results: Unlike many “simulations” that focus on single biological or biotechnology principles or concepts (e.g., genetic drift, PCR, etc.), the VBL offers a comprehensive set of labs within which students can explore these concepts and, more importantly, link them together either through a diversity of established exercises, by teacher-lead exploration, or by individual student hypothesis generation and testing. Students will have a virtual lab notebook to track the results of their work, store and manipulate data, and write up their insights and questions.

Dissemination Activities & Plans to Disseminate: The VBL will be available in January of 2010 through Pearson Publishers as a compliment to both their high school biology text and their college level biology texts. In addition, the software will be available through Pearson's "Mastering Biology".

Impacts of Project or Anticipated Impact: With these labs, both high school and beginning college biology students can enjoy open-ended exploration of core biological concepts in cell biology, genetics, evolution, ecology, and biodiversity.

Challenges: The Virtual Biology Lab will allow students to explore key biological concepts and biotechnologies for themselves (or under directed guidance) as they develop a greater understanding and appreciation for biological diversity and complexity.

Poster #4
Category: A1
Primary Project or Approach: Encouraging and Enabling Student Active Learning (Examples include Case Studies, POGIL, Clickers, Problem Based Learning)
Institution: Cal Poly, San Luis Obispo
Presenter: Susan Elrod
Email: selrod@calpoly.edu
Field of Interest within Biology: Genetics

Goals & Intended Outcome: Our goals are to 1) design Diagnostic Question Clusters (DQCs) that will help instructors identify commonly held misconceptions students have about key concepts in genetics, and 2) identify and develop instructional interventions that can be used in a variety of classroom settings to alleviate student confusion and increase student understanding of genetics.

Methods & Strategies: We have identified 4-6 major concept areas in genetics, and for each we are developing independent DQCs each containing up to 8 questions that traverse the depth of student understanding. Easy-to-adopt instructional interventions that utilize proven student-centered, constructivist techniques will be developed from reports in the literature, evidence from our own work and the work of collaborators.

Evaluation Methods & Results: Our evaluation plan involves using the fully developed DQCs in classrooms to identify student misunderstandings and instructional interventions to address and, hopefully, correct them. As DQCs are developed, they will be tested in classrooms then posted for wider dissemination. Student learning gains (Hake, 1998) will be calculated for each DQC that is developed. Validity and reliability testing will also be done. Associated interventions will be identified, developed and tested as well. Their effectiveness will be measured using student learning gains on the appropriate DQC with or without the intervention treatment. Five questions in a DQC regarding the ubiquity of genetic information are currently being tested and refined (internal reliability >0.8).

Dissemination Activities & Plans to Disseminate: We have presented posters on initial DQC development and textbook content analysis of the terms "gene" and "chromosome" (as interventions) at ASHG (American Society for Human Genetics) and ASCB (American Society of Cell Biology). Papers are
Developed DQCs with accompanying instructional interventions will be made available on NSDL.org, AIBS.org and our own website.

**Impacts of Project or Anticipated Impact:** DQCs differ from concept inventories in that they are discrete assessments for each targeted concept that can be used independently to help both instructor and student diagnose misconceptions and measure understanding pre- and post-instruction. We believe that this approach will help students develop a deeper understanding of the fundamental concepts in genetics, and will also expose instructors to a variety of alternative teaching strategies geared toward the improving understanding of the desired concept. Anecdotally, the author (Elrod) has altered her approach to teaching based on preliminary misconception findings in her classroom, using targeted assignments, images and case studies geared toward understanding of the specific concept and correction of the identified misconceptions.

**Challenges:** We were not expecting such vast reporting of misconceptions in the genetics education literature (currently 80+ papers), nor were we prepared to see the same misconception reported multiple times over many years without any obvious progress. Also, two other, very different concept inventories/assessments have been developed, so we are collectively challenged with presenting these different approaches to the educational community. We believe there is room for all to meet the needs of different instructors, students and institutions. We are also challenged by the most effective DQC/intervention dissemination mechanism and establishing broader collaboration for classroom testing at other universities. We also anticipate that the development of instructional interventions will not be a trivial matter.

**Poster #5**

**Category:** A1

**Primary Project or Approach:** Encouraging and Enabling Student Active Learning (Examples include Case Studies, POGIL, Clickers, Problem Based Learning)

**Institution:** California State University Fullerton

**Presenter:** Bill Hoese

**Email:** bhoese@fullerton.edu

**Co-Presenter:** Sean Walker, California State University Fullerton

**Field of Interest within Biology:** General Biology

**Goals & Intended Outcome:** Our primary objective is to improve student performance in the introductory majors biology course (Evolution and Biodiversity) that serves 400 students annually. Secondly, because CSUF is primarily a commuter campus, we seek to provide an opportunity for students to build peer networks and gain a sense of community.

**Methods & Strategies:** We implemented a modified model of supplemental instruction where advanced undergraduates lead voluntary discussion sections for students in Evolution and Biodiversity.

**Evaluation Methods & Results:** We monitored attendance at sessions and student performance in the course. Over five semesters approximately thirty percent of students took advantage of these sessions. The students who attended these sessions had higher exam scores and were more likely to pass than students who did not.

**Dissemination Activities & Plans to Disseminate:** We plan to disseminate via conferences and are writing a manuscript of our experiences.
Impacts of Project or Anticipated Impact: We experienced a positive impact on student performance with a manageable amount of faculty time investment. Our supplemental instruction leaders found that they enjoy teaching and learn more of the material as a result of their experiences.

Challenges: It has been difficult to offer supplemental instruction sessions during times that match well with student schedules. Faculty need to promote supplemental instruction sessions to the students, but once students begin attending sessions and they experience the benefits of supplemental instruction, they tend to continue attending throughout the semester. It has been challenging to identify supplemental instruction leaders.

Poster #6
Category: A1
Primary Project or Approach: Encouraging and Enabling Student Active Learning (Examples include Case Studies, POGIL, Clickers, Problem Based Learning)
Institution: Carnegie Mellon University
Presenter: Albert Corbett
Email: corbett@cmu.edu
Field of Interest within Biology: Genetics

Goals & Intended Outcome: This project is developing an intelligent learning environment for genetics problem solving. The goal is to help students develop a “robust” understanding of genetics problem solving which is grounded in conceptual domain knowledge, is well-retained, transfers more readily to related problem situations, and affords more efficient future learning.

Methods & Strategies: The project has developed a Cognitive Tutor for genetics problem solving, with about 145 problems spanning 12 topics. The tutor poses complex, multi-step problems and provides step-by-step accuracy feedback, and advice as needed. We are now developing Conceptually Grounded Learning Activities. e.g. self-explanation of worked examples, to prepare students for deeper reasoning in problem solving.

Evaluation Methods & Results: We have conducted focused evaluations of individual Genetics Cognitive Tutor units in a diverse set of 15 post-secondary institutions. In these focused studies we examined learning gains with pretest-posttest evaluations and an hour of problem solving has yielded an average learning gain of 18 points on a scale of 100, equivalent to almost two letter grades. Future evaluations at both the college and high school level will employ robust learning measures (retention, transfer, future learning) to evaluate the impact of the newly developed Conceptually Grounded Learning Activities on student learning in problem solving.

Dissemination Activities & Plans to Disseminate: Genetics Cognitive Tutor modules have been piloted in genetics and other biology courses in 15 colleges and universities, including public and private institutions, liberal arts institutions and research universities, and minority-serving universities. We are preparing to disseminate the tutor more broadly at the post-secondary level, and will begin piloting at the high school level in the coming year.

Impacts of Project or Anticipated Impact: The project has had an impact on genetics instruction at a limited number of colleges and universities to date. We anticipate a broad impact eventually, both because of the foundational role of genetics in the biological sciences and because of the heavy emphasis on problem solving in genetics education. There is a growing demand for genetics instruction at the post-secondary level, and genetics is a large and growing component of middle school and high school biology courses. At the same time genetics is viewed as one of the hardest topics in biology by students and instructors at all levels, and genetics is effectively a gateway course limiting the number
of biology majors at the post-secondary level. In summary, there is a growing need for effective problem solving support in genetics education.

**Challenges:** We have not encountered any unexpected challenges to date. One pragmatic challenge we anticipated and encountered is for instructors to find the room to incorporate additional learning activities in their courses. A partial solution to this challenge has been to implement a student modeling algorithm which monitors student learning and individualizes the number and types of problems presented to students. But the fundamental challenge (common to problem solving across STEM domains) is to support all students in developing a deep, robust understanding during problem solving.

**Poster #7**
**Category:** A1
**Primary Project or Approach:** Encouraging and Enabling Student Active Learning (Examples include Case Studies, POGIL, Clickers, Problem Based Learning)
**Institution:** Case Western Reserve University
**Presenter:** Joseph Koonce
**Email:** jfk7@cwru.edu
**Field of Interest within Biology:** General Biology

**Goals & Intended Outcome:** The goal of the course was to assist students in learning the fundamental principles of the regulation of structure and function of biological systems through study of evolutionary solutions to the challenges of multicellularity. I expected students to be able to analyze the structure and function relationships in both organism and population systems.

**Methods & Strategies:** The active learning methods of the course employed case studies, concept mapping, and student collaboration in teams. Mini-lectures explored examples of structure and function relations for plant and animal lineages and students were challenged to analyze other examples based on case studies. Similar approaches were used at the population level.

**Evaluation Methods & Results:** Evaluations of student learning gains relied on prior knowledge concept maps, student blog journals requiring reflection on learning gains and narrative explanations of case studies, and online self-assessment of learning gains. Although sample sizes are too small, there were many remarkable examples of knowledge gains from prior understanding. Because concept mapping skills were such an integral part of the evaluation, the next offering of the course will focus earlier on student mastery of these skills and make more thorough use of individual student tracking of learning gains.

**Dissemination Activities & Plans to Disseminate:** Dissemination of the results of this experiment with curriculum reform have been limited to discussion in learning circles for curriculum development in the Department of Biology. I anticipate wider dissemination during the fall at the University and through participation in National meetings.

**Impacts of Project or Anticipated Impact:** I have observed impacts on my own teaching, student performance in other courses, and on curriculum development in other introductory courses. Surprisingly, students have used the concept mapping tools in other courses to aid their learning and have encouraged others to try them. Variants of these methods have been tried in the majors introductory biology sequence with far less success.

**Challenges:** Several unexpected challenges arose during the first offering of the course. These included several issues associated with the pedagogy (effective learning objectives, consistent use of
mini-lectures, and effective use of assessments of learning gains from prior knowledge). However, the most pressing challenge was obtaining student buy-in to the approach to the subject matter. On pedagogical matters, I found it necessary to decrease the number of learning objectives and increasing their clarity for performance of students. To facilitate student acceptance, I will have to establish a more consistent pattern of activities.

Abstract: Evolution of Multicellularity -- Organizing Theme for Introductory Biology

This course development addressed a bias of mathematically oriented students against the study of biology and disinterest in introductory biology courses because of a perceived over-emphasis on learning through memorization. Using the theme of evolution of multicellularity, Biol 251 (Introduction to Organismal and Population Systems) employed active learning techniques and concept mapping to assist students in learning the fundamental principles of the regulation of structure and function of biological systems at the organismal and population levels. The evolutionary perspective facilitated learning about biological systems through a problem-solving approach to exploration of coupled challenge/solution templates. This course is the second of two introductory biology courses for the Department’s new B.S. in Systems Biology. Both courses use active learning techniques and emphasize structure function relationships, but differ in the reliance on concept mapping. Use of the concept mapping tool and the evolutionary theme proved to effective devices in focusing on a key set of biological principles. In contrast to traditional lecture formats for presenting this material, student learning gains in conceptual understanding of the interaction of structure and function in biological systems was striking. Comparison of prior knowledge and final concept maps of biological systems was an under recognized aid to learning gains.

Poster #8
Category: A1
Primary Project or Approach: Encouraging and Enabling Student Active Learning (Examples include Case Studies, POGIL, Clickers, Problem Based Learning)
Institution: City College of the City University of New York
Presenter: Sally Hoskins
Email: sallyh@sci.ccny.cuny.edu
Co-Presenter: Leslie M. Stevens, Univ. of Texas--Austin
Field of Interest within Biology: Neuroscience

Goals & Intended Outcome: We developed the C.R.E.A.T.E. (Consider, Read, Elucidate hypotheses, Analyze and interpret data, and Think of the next Experiment) approach to demystify and humanize science for undergraduates, originally at CCNY. We expanded the project to additional student cohorts, by training faculty at other schools. Faculty implemented CREATE in their own classes and assessed outcomes for students.

Methods & Strategies: We ran a series of faculty workshops to introduce faculty trainees from NY/NJ/CT to approaches used in the CREATE classroom. Faculty also observed video of actual CREATE classes, served as "students" in CREATE-lessons, interviewed students who had taken CREATE at CCNY, and student-taught CREATE before testing the approach on their home campuses.

Evaluation Methods & Results: Students of CREATE faculty implementers were assessed using the same mixed-methods approach used in the original CREATE study at CCNY. This included anonymous pre/post Likert style surveys of attitudes toward science, anonymous pre/post critical thinking tests, post-course surveys of learning gains, and a concept mapping assessment. Faculty workshops, and the performance of faculty, were evaluated by an outside evaluator. Data analysed to date suggest that the faculty training workshops were effective, faculty succeeded in implementing CREATE, and
Students on all campuses gained in ability to read/understand scientific literature. Data analysis continues, but it appears that CREATE is effective in diverse student cohorts.


**Impacts of Project or Anticipated Impact:** CREATE was successfully implemented on five institutions representing three different Carnegie Classifications. The seven implementations (two campuses had two CREATE faculty) involved 105 students. In all three key areas CREATE was designed to affect (ability to read and understand articles, feelings about science, understanding of the nature of science), students made significant changes. CREATE faculty have continued teaching CREATE, adapted it for additional courses, and have coached science (and on two campuses, humanities) colleagues in applying CREATE approaches. SH will teach two CREATE workshops in August 2009 at Universidad del Oeste (Puerto Rico), for an NIH-sponsored project to increase Hispanic student participation in science research careers.

**Challenges:** Even with training, some faculty who had always run teacher-centered classrooms (usually lectures) found it challenging to adapt to a student-centered approach. While students overall were enthusiastic, some initially balked when asked to do more than memorize. Some faculty had difficulties with time management and ran short on time for the late-semester 'emails to paper authors' step. We ran a midsemester workshop to bring implementing faculty together to share ideas and methods for circumventing snags, and also kept in touch by email during the implementation period. We ran a final workshop at the end of the implementation to capture recommendations from implementing faculty.

**Abstract:** C.R.E.A.T.E. faculty development and implementation at multiple institutions—demystifying and humanizing science for diverse cohorts of students.

The C.R.E.A.T.E. (Consider, Read, Elucidate hypotheses, Analyze and interpret data, and Think of the next Experiment) method is a guided approach to primary literature that has been shown to effectively demystify and humanize science for urban undergraduates at the City College of New York, one of the most ethnically diverse colleges in the U.S. To test the applicability of the method for additional cohorts of students, we ran a series of five monthly Create Faculty Development Workshops for faculty in the NY/NJ/CT area, training participants in CREATE classroom approaches. Seven of the workshop participants subsequently implemented CREATE in courses already planned on their home campuses.

The workshops and effectiveness of CREATE teaching, and student reaction to CREATE were assessed by an outside evaluator, and student performance and attitudes in CREATE classes assessed by the PIs using the same mixed methods approach as in the initial study (details in Hoskins et al., 2007; Genetics 186: 1381-1389). Data analysis is ongoing, and to date indicates that the workshops were successful, that faculty effectively implemented CREATE (at a range of colleges/universities representing three Carnegie Classifications) and that CREATE students on multiple campuses showed pre/post course shifts that parallel those seen originally at CCNY.

These results suggest that the CREATE method can be effectively taught by a variety of faculty, can be applied in numerous courses and contexts (biochemistry, biology, psychology), and that it is effective in diverse cohorts of students, from large urban universities to the Ivy League. We suggest that using close reading of primary literature coupled with email interviews of paper authors can effectively de-
Poster #9
Category: A1
Primary Project or Approach: Encouraging and Enabling Student Active Learning (Examples include Case Studies, POGIL, Clickers, Problem Based Learning)
Institution: College of Charleston
Presenter: John Peters
Email: petersj@cofc.edu
Field of Interest within Biology: General Biology

Goals & Intended Outcome: The goal of this project is to facilitate civic biological literacy in college non-science majors’ biology students by utilizing engaging problems/issues/questions of timely importance and/or local interest.

Methods & Strategies: The project utilized Problem-Based Learning (PBL) to teach the core concepts of biology from the perspective of civically engaging issues or problems. Related inquiry-based labs are designed to promote an understanding of the scientific discovery process.

Evaluation Methods & Results: Pre and post project focus group interviews, and the Student Assessment of Learning Gains (SALG) instrument was used to explore the following research questions: RQ1) How do students in lecture/content-based (traditional) and PBL/Inquiry-based non-science majors’ biology courses represent their perceptions of a) the role of science courses in their lives? b) the nature of the scientific process? c) independent and self-directed learning? RQ2) How does traditional and PBL/Inquiry-based instruction influence a) students’ interest, confidence, and engagement with science? b) students’ views about aspects of the course which helped them learn?

Dissemination Activities & Plans to Disseminate: A web site for this project has been established to provide teaching resources to help facilitate the transition to the PBL approach. Project methods and results have been presented at the International PBL Conference in Peru, The National Association of Biology Teachers, the National Marine Educators Association and the NSF CCLI conference in 2008.

Impacts of Project or Anticipated Impact: Compared to traditionally taught students, PBL student reported significantly higher confidence with respect to Science Literacy Skills and General Science Course Skills. They also reported greater interest in informally interacting with science. PBL students also expressed more literate conceptions of the nature of science; greater impact of strategies used in the course in facilitating independent and self-directed learning; and internalized more life-long learning skills and attitudes.

Challenges: There were no real unexpected challenges. However, encouraging faculty to make the transition to more inquiry-based, collaborative and student directed teaching methods was by far the most difficult aspect of the project. In the main we were, however, successful in encouraging the majority of faculty and graduate teaching assistants to adopt these methods.
**Poster #10**

**Category:** A1

**Primary Project or Approach:** Encouraging and Enabling Student Active Learning (Examples include Case Studies, POGIL, Clickers, Problem Based Learning)

**Institution:** East Tennessee State University

**Presenter:** Karl H. Joplin

**Email:** joplin@etsu.edu

**Co-Presenter:** Jeff Kniseley, Math, ETSU, Edith Seier, Math, ETSU, and Hugh Miller, Biology, ETSU

**Field of Interest within Biology:** General Biology

**Goals & Intended Outcome:** SYMBIOSIS is the response of the Departments of Biological Sciences and Mathematics at ETSU to address the recommendations of the BIO 2010 report. With a HHMI funded grant we have created a 3 semester course at the introductory level that integrates Biology and Mathematics.

**Methods & Strategies:** Symbiosis is an inquiry-based, active-learning curriculum in which math and biology are integrated into a coordinated three-course sequence. We have created the courses to reflect how biology and math is done by using datasets that the students analyze using the statistical and math tools taught.

**Evaluation Methods & Results:** Our initial approach is to test students on biology concepts and mathematics/statistics skills before and after each module or at the beginning of each semester for each of the course sequences. In addition, we are developing an assessment tool that will allow us to compare SYMBIOSIS students with students completing the current, more traditional curriculum. Additionally, several longitudinal studies will follow the SYMBIOSIS students with respect to success in upper level courses, participation in undergraduate research projects.

**Dissemination Activities & Plans to Disseminate:** We have held two workshops for surrounding institutions to introduce instructors to our methods. We have given a number of presentations at Math and Biology forums concerning our program. Articles are being written for publication.

**Impacts of Project or Anticipated Impact:** We have seen an increased understanding of concepts form students taking this course. The results of our longitudinal studies are still taking place. The Department of Biological Sciences will implement this curriculum as the standard Biology Majors introductory series with a co-requisite math course (Stats for SYM I and Calculus I for SYM II). The Department of Math and Biological Sciences are working on a concentration in Quantitative Biology. We have taught this curriculum to High School students for the last two years as a Tennessee Governor’s School.

**Challenges:** We have to decrease the teaching requirements so that a Math and Biology Faculty is not required for each session. To do this separate sessions are being developed in the respective departments for each cohort of students that will either use biology examples (in the Math courses) or analysis of datasets that Math is using (in the Biology courses). There has been resistance from Professional Schools in accepting our integrated courses. Separate listings of the course credits are being given on the transcripts.

**Abstract:** SYMBIOSIS at East Tennessee State University represents our response to the BIO 2010 report. Under a HHMI funded curriculum grant the departments of Biological Sciences and Mathematics have developed a three semester introductory course that is an inquiry-based, active-learning curriculum in which math and biology are integrated into a coordinated three-course sequence (SYMBOISOS I, II, & III). Material from 3 introductory biology courses (Cell/Molecular, Structure/
Function of Plants & Animals, Population Biology / Ecology / Evolution) is integrated with 2 courses from math (Calculus I, Probability & Statistics, plus several components from other math courses). Assessment of the student’s development demonstrate that they have a better understanding of the role quantitative tools can be used in the way biology is actually done.

**Poster #11**

**Category:** A1  
**Primary Project or Approach:** Encouraging and Enabling Student Active Learning (Examples include Case Studies, POGIL, Clickers, Problem Based Learning)  
**Institution:** Emory University  
**Presenter:** Christopher Beck  
**Email:** christopher.beck@emory.edu  
**Co-Presenter:** Lawrence Blumer, Morehouse College  
**Field of Interest within Biology:** General Biology

**Goals & Intended Outcome:** We are developing a bruchid beetle as a model system for inquiry-based laboratory courses. We have developed materials that can be used to develop faculty expertise in using bean beetles. We are creating a curriculum development network for faculty to broaden the disciplines covered.

**Methods & Strategies:** We developed a dedicated website to disseminate information on bean beetle biology and laboratory techniques. We make hands-on workshop presentations at national meetings at which faculty conduct an experiment using an inquiry-based pedagogy. The curriculum development network uses multi-day faculty workshops.

**Evaluation Methods & Results:** We used a pre-test/post-test format to evaluate student understanding of the scientific method, confidence in addressing scientific questions, and scientific reasoning. Eight semesters of assessment data on 85 students in the ecology laboratory courses at Emory and Morehouse show positive positive effects from pre-test to post-test performance. In addition, end-of-course rating of bean beetle studies suggest rated these studies as the best in increasing understanding of science methods (54% of responses) and most helpful reinforcing lecture concepts (positive ranks in majority of responses).

**Dissemination Activities & Plans to Disseminate:** We have presented seven hands-on workshops to more than 200 faculty and staff using guided-inquiry teaching methods. We continue to develop our website to disseminate information to a broader audience. Our Curriculum Development Network is working on new guided-inquiry laboratories in different disciplines.

**Impacts of Project or Anticipated Impact:** We have developed seven innovative laboratory protocols that incorporate inquiry-based learning. These experiments have been disseminated to college faculty who have adopted them in their undergraduate courses both introductory and upper-level. Our new experiments have increased student understanding of the scientific method and interest in science. We have developed a comprehensive website <www.beanbeetles.org> on this model system. Based on a survey of workshop participants, nearly 3000 students have used bean beetles in a laboratory course.

**Challenges:** Although hands-on workshops are the most effective way to disseminating laboratory curricula, conducting such workshops with live organisms is not common at most scientific meetings that are oriented toward speakers and poster presentations. We have overcome this limitation by de-
signing simple experiments and purchasing all the basic supplies needed for laboratory workshop presentations. This has enabled us to successfully conduct workshops in hotel meeting rooms at several national meetings.

Abstract: Undergraduate laboratories are often limited by the availability of a tractable live animal model system. Furthermore, the connections between experiments in teaching laboratories and those carried out in the research community are often tenuous. The bruchid bean beetle, Callosobruchus maculatus, is a very easily cultured and manipulated animal that is widely used in ecology, evolution and behavior research. The goal of our NSF CCLI Phase 1 project was to develop C. maculatus as a model system for use in undergraduate laboratories. We continue this work in a Phase 2 project by creating a bean beetle curriculum development network for faculty.

Poster #12
Category: A1
Primary Project or Approach: Encouraging and Enabling Student Active Learning (Examples include Case Studies, POGIL, Clickers, Problem Based Learning)
Institution: Ferrum College
Presenter: Carolyn Thomas
Email: cthomas@ferrum.edu
Co-Presenter: Bob Pohlad, Ferrum College
Field of Interest within Biology: Ecology and Environmental Biology

Abstract: Experiential Nature Studies for Teaching Biology

Experiencing nature as an approach to teaching biology is used extensively in our classes at Ferrum College. Our 800 acre rural campus in the mountains of Virginia provides excellent opportunities for students to experience nature first hand. We use the hands on approach to learning how organisms live, function and interact with other each other. The concepts of evolution, population biology, organism physiology and anatomy can all be incorporated in the studies and discussions in class. Both field and laboratory studies involve the students collecting and analyzing data and therefore also incorporating mathematics and statistics in the learning experience.

Poster #13
Category: A1
Primary Project or Approach: Encouraging and Enabling Student Active Learning (Examples include Case Studies, POGIL, Clickers, Problem Based Learning)
Institution: Florida Gulf Coast University
Presenter: Nora Demers
Email: ndemers@fgcu.edu
Co-Presenter: Charles W. Gunnels IV, Florida Gulf Coast University
Field of Interest within Biology: General Biology

Goals & Intended Outcome: Our goal is to enhance student interest and understanding of General Biology, including concepts and content in cellular and molecular biology as well as genetics. The desired outcome was students who possessed a working understanding of these concepts that they could apply to their upper-division courses.

Methods & Strategies: We sought to seamlessly integrate a variety of teaching strategies into a SCALE-UP classroom (Student-Centered Activities for Large Enrollment Undergraduate Programs). In
each session, we blended traditional lectures with hands-on activities, laboratory experiments, and classroom discussions.

**Evaluation Methods & Results:** Pass Rates & Retention Pre- and Post-test water worksheets Student Evaluations Time budget & time series data

**Dissemination Activities & Plans to Disseminate:** We intend to disseminate our efforts through presentations at the Whitaker Center for STEM education at Florida Gulf Coast University. In addition, we will disseminate our findings at conferences and through the development of peer-reviewed manuscripts for submission to teaching and learning journals.

**Impacts of Project or Anticipated Impact:** Most importantly, our strategy appears to result in improved pass rates and retention; students appear to find greater success. This effort also appears to be impacting the instruction of other faculty teaching Biology 1 at Florida Gulf Coast University. For example, colleagues have requested information about our teaching strategies, including teaching tools. In addition, we have already earned a Creative Course Redesign in General Education Faculty grant for this effort.

**Challenges:** Our greatest challenges were not unexpected. The most difficult part of this integrative teaching strategy was coordinating the timing of events so that we could create a seamless transition between the different learning processes. This coordination took a lot of effort outside of the classroom where we could plan each class and develop authentic assessments inside and outside of the class. We also had to assess our successes and failures through trial and error as well as practice. Our second major challenge was coordinating content delivery within that time allotted. We had to deliberate about the content, as we agreed about how, and at times which, topics would be stressed in this introductory biology class.

**Abstract:** Integrative Teaching developed for a SCALE-UP (Student Centered Activities for Large Enrollment Undergraduate Programs) class in General Biology I

The ultimate goal of educating students is to help create learners with a greater appreciation and understanding of the material as well as developing life-long learners. In our section of Biology 1 at Florida Gulf Coast University, we attempted to enhance our student’s scientific skill set and content knowledge as well as their quantitative and critical thinking skills in order to improve their success in upper division coursework. We accomplished our goals by developing an integrative teaching approach, where created classes based on seamless transitions between traditional lectures, hands-on activities, laboratory experiment, and classroom discussions in a team-taught large-section class. For example, hands-on activities punctuated traditional lecture that were then enhanced with student discussion and feedback. This integrative design allowed us to test our assumptions about how well we covered the material through immediate feedback using the hands-on activities and classroom discussions. Experimental labs were used to emphasize and reinforce concepts, but we were vigilant to ensure that the labs also strengthened the student’s quantitative evaluation of results as well as developing an understanding of experimental design, including the use of treatments and controls. On-line quizzes on readings and labs helped assure students came to class prepared to learn. We gave our students an opportunity to take a collaborative test in groups of 2-3 after completing a traditional individual assessment. These group tests helped students solidify their critical thinking skills via discussions to achieve a greater understanding of the topic as well as improve their test taking skills. The diversity of teaching styles addressed the different learning style of students, allowing each student to benefit from different instructional techniques. This collaboration also allowed us, as team-teachers, to share and evaluate our favorite teaching strategies as well as content examples, skills, and assessments. We evaluated the effectiveness of this integrative approach through comparison of grades and retention among different sections of Biology 1, pre- and post-tests, student reflection of learning, and student evaluations.
Poster #14
Category: A1
Primary Project or Approach: Encouraging and Enabling Student Active Learning (Examples include Case Studies, POGIL, Clickers, Problem Based Learning)
Institution: Georgetown University
Presenter: Peter Armbruster
Email: paa9@georgetown.edu
Co-Presenter: Maya Patel, Department of Education, Cornell University; Erika Johnson, Department of Biology, Georgetown University and Martha Weiss, Department of Biology, Georgetown University
Field of Interest within Biology: Evolutionary Biology

Goals & Intended Outcome: We describe the development and implementation of an instructional design that focused on bringing multiple forms of active learning and student-centered pedagogies to a one-semester, undergraduate introductory biology course for both majors and non-majors

Methods & Strategies: 1) Reordering the presentation of the course content in an attempt to teach specific content within the context of broad conceptual themes, 2) incorporating active and problem-based learning into every lecture, and 3) adopting strategies to create a more student-centered learning environment.

Evaluation Methods & Results: Assessment of our instructional design consisted of a student survey and comparison of final exam performance across three years, one year before our course redesign was implemented (2006) and during two successive years of implementation (2007, 2008).

Dissemination Activities & Plans to Disseminate: A summary of our course restructuring has been accepted for publication in CBE-Life Science Education and will be published sometime this year.

Impacts of Project or Anticipated Impact: Based in part on the positive student reactions to interactive and student-centered pedagogy in Introductory Biology II, four instructors have implemented the use of clickers in their courses and one faculty member recently attended the 2007 National Academies Summer Institutes on Undergraduate Education in Biology.

Challenges: The course redesign we implemented required a significant time investment both in the approximately six months of preparation and during the first semester of implementation. However, once the redesigned course had been taught for the first time in 2007, teaching the redesigned course in 2008 did not require a significant additional time commitment relative to before our changes were implemented. Nevertheless, the increased positive student response to the course was sustained.

Poster #15
Category: A1
Primary Project or Approach: Encouraging and Enabling Student Active Learning (Examples include Case Studies, POGIL, Clickers, Problem Based Learning)
Institution: Georgia Institute of Technology
Presenter: Rupal Cutting
Email: rupal.thazhath@biology.gatech.edu
Field of Interest within Biology: General Biology

Goals & Intended Outcome: The goal of this study was to assess the impact of peer led undergraduate study (PLUS) in a sophomore level genetics class at Georgia Tech. The anticipated outcome was to see a measurable difference between PLUS and non-PLUS attendee performance in the course.
Methods & Strategies: Plan: Measure gains in critical thinking and problem solving skills Method: Select Peer Leaders, train peer leaders in collaborative learning strategies, PLs hold discussion groups weekly and lead student group work outside of class.

Evaluation Methods & Results: Evaluation methods: Assessed exam questions covering each topic at upper (Analysis, Synthesis, Evaluation) and lower (Knowledge, Comprehension, Application) Captured PLUS attendance data Controlled for ability and previous experience Compared PLUS and non-PLUS performance on Higher and lower level questions Results: PLUS participants experienced greater cognitive gains in higher level problem solving than their non-participant peers.

Dissemination Activities & Plans to Disseminate: We plan to continue this project and collect more data and publish in an education research journal

Impacts of Project or Anticipated Impact: Our hope is that GA Tech will adopt the PLUS program strategy to support challenging STEM courses (not just Biology).

Challenges: No funding: Recruited volunteer peer leaders but we hope to be able to obtain funding to support this program and pay the Peer Leaders over time. Low attendance at PLUS sessions: We advertised the sessions more in class with the help of the instructor.

Abstract: Measuring Cognitive Outcomes of Peer Led Undergraduate Study in Genetics

Peer Led Undergraduate Studies (PLUS), more popularly known as Supplemental Instruction (SI) has been used successfully at over 1500 institutions across 29 countries. Here, we describe the pilot program in the School of Biology at Georgia Institute of Technology, implemented in BIOL 2344 (Genetics) during spring semester 2009. We measured cognitive outcomes by comparing PLUS and non-PLUS attendee performance on exams, while controlling for ability and previous experience. PLUS participants experienced greater cognitive gains in higher level problem solving than their non-participant peers. Our hope is to implement PLUS across all introductory level courses at Georgia Tech.

Poster #16
Category: A1
Primary Project or Approach: Encouraging and Enabling Student Active Learning (Examples include Case Studies, POGIL, Clickers, Problem Based Learning)
Institution: Georgia Southern University
Presenter: Laura Regassa
Email: LRegassa@GeorgiaSouthern.edu
Field of Interest within Biology: General Biology

Goals & Intended Outcome: This project will provide effective undergraduate biology education in a gateway course using guided-inquiry/project-based learning. Anticipated student outcomes include acquisition of a foundation in disciplinary knowledge, conceptual frameworks, and discipline-specific/interdisciplinary skills.

Methods & Strategies: The curriculum focuses on four long-term assisted inquiry projects. Each project is centered on a different model organism and assigned to 2 groups per class. In addition, basic skills are introduced and then built upon in short, repetitive snapshots that are reinforced by out of class activities.

Evaluation Methods & Results: Preliminary evaluation showed substantial learning gains in the test section. Knowledge and skill gains were evaluated using a pre/posttest format, with the PI-taught test
sections (89% correct) out-performing their peers in the control sections (39% correct). Recently, the pilot curriculum was taught by two additional instructors, but post-course evaluation indicated instructional difficulties. The formative evaluation indicated the need for faculty professional development, as the instructors were uncomfortable with students constructing their own knowledge in a fast-paced, guided inquiry curriculum.

**Dissemination Activities & Plans to Disseminate:** Preliminary results for the gateway course curricular revision were presented at the 2008 ISSOTL conference: Regassa, L.B. and A.I. Morrison-Shetlar. 2008. A molecular biology studio course at the crossroads: undergraduate teaching, research and service. ISSOTL Abs. No. B29.

**Impacts of Project or Anticipated Impact:** To date, all impacts have been departmental. Students enrolled in the pilot sections have benefited from enhanced learning outcomes and the on-going curricular revision has fostered discussion within the department.

**Challenges:** Our main challenge in the large gateway course has been the number of instructors and their varied backgrounds and teaching styles/experience. A recent attempt to include 2 new instructors in the pilot curriculum was informative. They lacked the skills to manage a classroom where students were undertaking guided inquiry projects, and weekly pre-course meetings were insufficient to overcome the need for additional professional development. Students perceived this situation as a lack of preparation on the part of the instructors.

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**Poster #17**  
**Category: A1**  
**Primary Project or Approach:** Encouraging and Enabling Student Active Learning (Examples include Case Studies, POGIL, Clickers, Problem Based Learning)  
**Institution:** Georgia State University  
**Presenter:** William Said  
**Email:** wsaid@gsu.edu  
**Co-Presenter:** Therese Poole, Doyle Barrow, and Dabney Dixon, Georgia State University  
**Field of Interest within Biology:** Ecology and Environmental Biology  

**Goals & Intended Outcome:** To enhance student success and therefore student retention ratio in biology and chemistry classes at GSU; and to improve student learning in biology and biochemistry courses. Linking the common concepts in biology and chemistry together will facilitate the understanding and relevance of the topics in biology and chemistry and help students better integrate the two disciplines.

**Methods & Strategies:** Starting with general chemistry classes, production of slides, using biologically relevant problems and more advanced examples. In addition the vocabulary of the two disciplines will be examined in an effort to ensure that common language is used to communicate important topics.

**Evaluation Methods & Results:** Evaluation will be based on students performance the exit exams in general chemistry. It is expected that with increased emphasis on the more relevant topics and examples which are more easily visualized that the scores would increase. Because molecular cell biology is not taken until a year after the general chemistry sequence we would track student performance in that course starting in Fall of 2010. Student performance on a subset of exams 1 and 2 which use chemistry topics will be tracked.
**Poster Abstracts**

**Dissemination Activities & Plans to Disseminate:** Publication in science education journals.

**Impacts of Project or Anticipated Impact:** It is expected that with increased emphasis on the more relevant topics and examples which are more easily visualized that the scores would increase.

**Challenges:** It's possible that this process will require the “weeding out” of some traditional topics which are no longer relevant, thus allowing a greater emphasis on the more relevant topics and the addition of biological examples and illustrations which will be help students make connections between the chemistry and biology.

**Poster #18**  
**Category:** A1  
**Primary Project or Approach:** Encouraging and Enabling Student Active Learning (Examples include Case Studies, POGIL, Clickers, Problem Based Learning)  
**Institution:** Inter American University of Puerto Rico  
**Presenter:** Yolanda Serrano-Nunez  
**Email:** yserrano@bc.inter.edu  
**Co-Presenter:** Ana M. Lugo-Chinchilla  
**Field of Interest within Biology:** General Biology

**Goals & Intended Outcome:** 1. Improve learning of the students in the Biology Program. 2. Increase students retention in the Biology Program. 3. Actualize laboratories exercises.

**Methods & Strategies:** 1. Written and practical exams 2. Interview (by telephone) 3. Oral and written presentations 4. Questionnaires

**Evaluation Methods & Results:** 1. Written exam to students that finished their degree that year. 2. Practical laboratory exam to students that finished their degree that year. 3. Telephone interview to students who graduated from our Biology Program. 4. Questionnaires answered by professors and peer students.

**Dissemination Activities & Plans to Disseminate:** 1. Presentation of our results from the Assessment Plan to the Assessment Committee of our institution 2. Presentation of our results to the faculty of the Natural Science Department. 3. Presentation of our results in different forums.

**Impacts of Project or Anticipated Impact:** 1. This assessment project will impact all the biology students in our program. 2. Valuate the assessment process as a tool to improve the teaching and learning process.

**Challenges:** 1. It is difficult to involve some faculty members in the assessment project. Faculty involve in research only have one or two courses during the year. 2. It is difficult to find students that have lefted the institution, because their address or telephone number have changed. At the time they attend the graduation event a questionnaire is given to them to ask important information for us.

**Abstract:** Assessment of the Biology Program of the Inter American University of Puerto Rico, Bayamón Campus

An assessment plan was developed according to the Biology Program goals of the Inter American University, Bayamon Campus. For each goal one or more assessment instruments were created, which included: a written exam, a practical laboratory exam, an oral and written presentation, two question-
naires and a telephone interview to graduate students from our program.

A committee, composed of biology professors and an assessment specialist, developed all the assessment instruments. The validation process was performed by part-time biology professors and graduate students. The assessment plan includes a total of eleven biology courses.

The application of the assessment instruments produced the following results: a 30% of the students obtained 70% or more in the written exam, a 95% of the students showed proficiency in the practical laboratory exam, a 74% and an 87% of the students showed competency in the oral presentation and in the written presentation respectively and a 78% showed capacity to work in group.

Some of the recommendations given by the graduate students through the telephone interviews were: to provide more laboratories exercises, to give practical exams in the lab, also to give more theory in the labs, and to increase the courses as the Laboratory Skills II, which introduced them to research experiences.

With the information acquired through this assessment process we will: emphasize the topics which were less understood by students in the written exam; integrate research in other laboratory courses and increase oral presentations and analysis of scientific papers in different courses.

**Poster #19**

**Category:** A1

**Primary Project or Approach:** Encouraging and Enabling Student Active Learning (Examples include Case Studies, POGIL, Clickers, Problem Based Learning)

**Institution:** Lincoln University

**Presenter:** Staria Vanderpool

**Email:** vanderpools@lincoln.edu

**Field of Interest within Biology:** General Biology

**Goals & Intended Outcome:** Undergraduate, non-science majors complete Introductory Biology and lab as part of the general education core. Our goal was improved student engagement and learning by implementing an investigative, hands-on lab experience for approximately 1450 students in 50 sections, taught by graduate assistants.

**Methods & Strategies:** We chose to develop and implement problem-based learning and collaborative learning experiences as contrasted with traditional confirmational laboratory experiences. Results of open-ended outcomes were communicated through reports and presentations enhancing cross-discipline general education objectives.

**Evaluation Methods & Results:** Thirteen sections continued to complete confirmational labs for two years while the remainder completed problem-based labs. Evaluation of student outcomes in each group included pre- and post-assessment of student attitudes to science, content acquisition, and critical thinking ability. Evaluation results were compared within and between two instructional models. Focus groups were conducted by an external evaluator. Student content acquisition was similar for both groups. Students in investigational labs had enhanced analytical skills and showed significant positive attitudes toward science and technology.

**Dissemination Activities & Plans to Disseminate:** Dissemination activities included presentations at national conferences (2), development and presentation of a workshop at a national meeting, and publication of a lab manual. We continue to work on papers for publication of outcomes based on evaluation data, and implementation programs.
**Impacts of Project or Anticipated Impact:** We developed a course management strategy for biology labs that allows large programs to offer investigative, open-ended labs staffed with teaching assistants (TA). The TA training developed for the biology program was extended to a two-day GTA training program for the department. At the end of the two year implementation all sections of the lab were investigative labs. The infrastructure and development of hands-on labs is being implemented in introductory labs for majors. Individual units have been adopted by other institutions, and the course package is available by other programs.

**Challenges:** Programs with successful investigative labs for biology students tended to be in small programs taught by faculty and staff. Our challenge was to develop problems appropriate for non-science majors that could be offered for large numbers in labs staffed by TAs. Our TAs required additional training to teach in open-ended investigational labs and to mentor collaborative group learning. As a result, I designed, wrote and implemented investigative labs rather than being able to adopt existing materials. I also developed and implemented training and support systems that enabled TAs to staff the labs.

**Poster #20**  
**Category:** A1  
**Primary Project or Approach:** Encouraging and Enabling Student Active Learning (Examples include Case Studies, POGIL, Clickers, Problem Based Learning)  
**Institution:** Louisiana State University  
**Presenter:** Isiah Warner  
**Email:** iwarner@lsu.edu  
**Co-Presenter:** Su-Seng Pang, Melissa Crawford, Lakenya Holmes, Misty Johnson, Cade Register, Gretchen Schneider, Zakiya Wilson, Eugene Kennedy, Saundra McGuire; Louisiana State University  
**Field of Interest within Biology:** Chemistry  

**Goals & Intended Outcome:** The LSU Office of Strategic Initiatives focuses on activities that assist with increasing the educational research and scholarly productivity of faculty and the quality and competitiveness of our students. We impact STEM education by engaging students in mentoring and research.

**Methods & Strategies:** OSI recruits students with great potential for success; pairs these with faculty and peer mentors; teach learning and study strategies which maximize students' learning potential; provide opportunities and preparation for graduate study; and engage students in research early and continuously.

**Evaluation Methods & Results:** Our assessment plan involves a continuous process in which the management, implementation, and outcomes are studied on a semester and annual basis and consists of both internal and external components. The external study involves extensive input from groups of experts, e.g. a Site Visit Team from the National Science Foundation and Research Corporation, an External Advisory Board, and an External Evaluation Team. The internal component involves both formative and summative assessments and includes observations of program activities, and interviews and surveys of administrators and participants.

**Dissemination Activities & Plans to Disseminate:** To date, we have shared the results of this project in locally within the LSU community as well as through numerous presentations. We are currently working on several publications for peer-reviewed journals that will highlight our activities and the outcomes of these.
Impacts of Project or Anticipated Impact: Through systematic mentoring and research engagement, we find that our participants regularly achieve higher cumulative grade point average than the comparison groups. We also have a higher percentage of participants entered their senior college, an indicator of progression, by the beginning of their second year. Our minority students show a general trend in which OSI participants outperform their counterparts, particularly in relation to GPA indicators. Notably, our participants complete STEM degrees at a much higher rate than their peers.

Challenges: We consistently meet challenges through innovative programmatic and administrative adaptations.

Abstract: Mentoring and Research: Transforming Undergraduate Education

Mentoring and research are important tools for transforming undergraduate education in science, technology, engineering, and mathematics (STEM). Through such experiences, aspiring scientists are engaged in meaningful learning that transcends classroom teaching into applications of relevance to real-world challenges. In addition, mentoring and research synergistically impact student retention and provide the preparatory background for long term careers in STEM fields. Through funding from the National Science Foundation, the National Institutes of Health, Research Corporation, and the Louisiana Board of Regents, the Office of Strategic Initiatives at Louisiana State University provides a host of programs, services, and opportunities for students with exceptional promise for academic and research achievements. We believe that the hallmarks of all of these programs are our mentoring and research activities. Combining these with academic advising and interventions, and financial support, our staff works collaboratively with faculty to provide students with the foundation needed to excel in undergraduate programs of study. Through these interventions and support, we have realized growth in the retention and graduation rates of program participants. Beyond simple subsistence in STEM fields, we have seen an increase in graduating GPAs of our students, as well as an increase in the number of program participants garnering national awards.

Poster #21
Category: A1
Primary Project or Approach: Encouraging and Enabling Student Active Learning (Examples include Case Studies, POGIL, Clickers, Problem Based Learning)
Institution: Marquette University
Presenter: Thomas Eddinger
Email: thomas.eddinger@marquette.edu
Co-Presenter: Michelle Mynlieff, Marquette University
Field of Interest within Biology: General Biology

Goals & Intended Outcome: To facilitate student understanding of unfamiliar biological concepts.

Methods & Strategies: Activities are designed to get the students attention and develop personal interest in the biological concept being taught. Students are encouraged to participate in familiar activities in the classroom to show the relevance of the concept and develop interest in how biological regulatory mechanisms can explain feedback regulation.

Evaluation Methods & Results: Evaluation of student learning is accomplished by in class clicker questions, group activities, problem solving and examinations.

Dissemination Activities & Plans to Disseminate: Dissemination is by word of mouth, and posters at meetings such as this on how to improve teaching.
**Impacts of Project or Anticipated Impact:** The impact of these using these techniques is increased student attendance at lecture, improved student retention, improved performance on assessment, and improved feedback on teaching evaluation forms.

**Challenges:** Time constraints. While these activities are well received, they are time intensive.

**Abstract:** Teaching novel and often difficult concepts can be a challenge for instructors of introductory courses where the students may be indifferent to the topic material, unfamiliar with the terminology, and have trouble seeing the relevance to their lives currently or in the future. In an attempt to address all of these issues, we have tried to incorporate classroom activities that help the students comprehend what can be difficult concepts. These activities require active participation by the students, and try to incorporate things they are familiar with to develop the student’s interest in the topic as well as showing its relevance in their lives. Activities used to date include using voluntary control of breathing to introduce the topic of regulation of respiration, a telephone tree to introduce the concept of second messenger signaling and amplification, and modeling of pH regulation using students, balls, and a mock cell. All of these activities have received positive feedback from the students and seem to improve understanding of the biological concepts they introduce. Identifying additional activities for other concepts in addition to the use of other active learning techniques will enhance the overall participation, enjoyment and ultimately the learning of the students.

**Poster #22**

**Category:** A1

**Primary Project or Approach:** Encouraging and Enabling Student Active Learning (Examples include Case Studies, POGIL, Clickers, Problem Based Learning)

**Institution:** Maryville University

**Presenter:** Jeffrey Sich

**Email:** jsich@maryville.edu

**Field of Interest within Biology:** Microbiology, Virology

**Goals & Intended Outcome:** Students of science can learn much about the nature of their discipline through a careful analysis of the history of science and the figures and events involved in the development of key concepts of a field. This project used film to introduce introductory microbiology students to the history of microbiology.

**Methods & Strategies:** A new film on Ignaz Semmerlweis and the search for the cause of childbed fever was used in the first day of class. Student response to the film was assessed two weeks after its use in class, at the same time as the scheduled third-week course evaluation.

**Evaluation Methods & Results:** Thirteen of 14 student responded that the film was effective, or very effective, in creating an understanding of the state of medical science in 1849 and nine students (64%) responded that the film was more effective, or much more effective, in conveying basic information about early studies of childbed fever compared to a case study distributed in class. These results suggest that film can be an effective tool for conveying a deeper understanding of the historical period inhabited by early microbiologists and should be considered for use in the classroom.

**Dissemination Activities & Plans to Disseminate:** A poster was presented at the 15th Annual American Society for Microbiology Conference for Undergraduate Educators (ASMCUE) in 2008.

**Impacts of Project or Anticipated Impact:** Because of favorable student response to the film, I anticipate focusing the remaining first session of the course on issues raised by the film regarding the status of infectious disease scholarship in 1850. If students are able to identify the questions that
needed to addressed to establish a cause-effect relationship between microbes and disease, they may be more engaged in the material from Day One.

Challenges: None.

Abstract: Using Film to Enhance the Teaching of the History of Microbiology

Students of science can learn much about the nature of their discipline through a careful analysis of the history of science and the figures and events involved in the development of key concepts of a field. Most microbiology textbook writers recognize this and practically all begin with a brief description of the history of microbiology and the scientists who made major contributions. To effectively teach the history of microbiology, science faculty need to be aware of the challenges faced by their history colleagues. A 1998 statement by the American Historical Association described the need to improve the effectiveness of teaching history and argued using film and other visual resources to enhance the classroom experience. Because short films are frequently promoted as useful tools for triggering classroom discussion, capturing the attention of students and stimulating an emotional response to the subject matter, a new film on Ignaz Semmelweis and the search for the cause of childbed fever was used in the first day of an introductory microbiology class for nursing students. Semmelweis, written, directed and photographed by Jim Berry, was completed in 2001 and has appeared in more than 30 film festivals worldwide. Production of this 17-minute black and white film was supported by the Alfred P. Sloan Foundation and is available for classroom use at www.scienceandfilm.org/films.php. Student response to the film was assessed two weeks after its use in class, at the same time as the scheduled third-week course evaluation. Thirteen of 14 student responded that the film was effective, or very effective, in creating an understanding of the state of medical science in 1849 and nine students (64%) responded that the film was more effective, or much more effective, in conveying basic information about early studies of childbed fever compared to a case study distributed in class. These results suggest that film can be an effective tool for conveying a deeper understanding of the historical period inhabited by early microbiologists and should be considered for use in the classroom.
**Evaluation Methods & Results:** Pre- and post-semester NOS understandings were assessed quantitatively via Views on Science-Technology Society and qualitatively via Views of Nature of Science, Form B. Other data included lab observations, student written work, student interviews, student exam performance, and surveys of student learning. Preliminary analyses have suggested that students in the inquiry sections were better able to work with and interpret data cooperatively. Although students in ER sections indicated they learned more about NOS, preliminary analyses of the data have not identified differences among treatments.

**Dissemination Activities & Plans to Disseminate:** Project results have been presented at two conferences, and a manuscript is currently in review. The lab manual is undergoing revision for fall 2009, at which time another semester of data will be collected. The pedagogies that improve student learning will be disseminated as part of the project.

**Impacts of Project or Anticipated Impact:** The pedagogy of the introductory biology lab has been converted from emphasizing rote lab skills and technical writing to emphasizing scientific thinking and communication. The success of this project has resulted in another introductory biology laboratory adopting some of the same techniques for their course revision. The lab has become a unifying point for biology faculty to meet and discuss goals and outcomes for introductory biology. For graduate students, the lab has given them an opportunity to experience new teaching techniques and explore their own NOS understanding.

**Challenges:** Despite providing a pre-semester workshop and support throughout the semester, graduate student implementation of the curriculum varied. In fall 2009 we are creating PowerPoints to guide each lab’s implementation and employing undergraduate assistants in each lab. Due to a heavy reliance on lab reports for grades, and the tendency to grade only technical writing skills, the course assessment did not always match the lab goals. In fall 2009 we are altering assignments, instructing graduate students on grading, and assessing student NOS understanding to clarify the expectations for student learning in the course.

**Poster #24**
**Category:** A1
**Primary Project or Approach:** Encouraging and Enabling Student Active Learning (Examples include Case Studies, POGIL, Clickers, Problem Based Learning)
**Institution:** NC State University
**Presenter:** Miriam Ferzli
**Email:** mgferzli@ncsu.edu
**Field of Interest within Biology:** General Biology

**Goals & Intended Outcome:** To increase active learning in the large introductory biology courses for majors using combinations of various learning technologies such as personal response systems and virtual training environments.

**Methods & Strategies:** I have been using problem-based learning in conjunction with various learning technologies such as personal response systems and virtual training environments.

**Evaluation Methods & Results:** The data is preliminary at this point, since the project is a pilot study; but I collected data from students via survey responses. Students who participated in the virtual environment were compared to those who opted out. I also compared general success in the course as measured through exam grades for these two groups of students.
Dissemination Activities & Plans to Disseminate: If the project can show success in one section of the first part of the introductory biology course (there are four to five sections offered for each part one and two), the goal is to scale it up to the other sections.

Impacts of Project or Anticipated Impact: I would like to show how much students may benefit from having an added problem session to their introductory biology course. This may help justify funding for conducting these sessions in physical settings as well. The overall goal is to offer the opportunity for students to choose the virtual or physical version of the problem session.

Challenges: The main challenge is finding the personnel resources for moderating the problem sessions. I used undergraduate honor students and graduate students to help me, but there needs to be a better system in place for sustaining the program and for running the sessions in a consistent manner during future scale up.

Abstract: Active Learning in Introductory Biology Lecture Courses Using Synchronous Virtual Spaces

As the number of students continues to increase in the introductory biology majors courses, the lack of physical space and the large number of students (>240 students) in each lecture section become limiting factors for implementing active learning approaches in small collaborative groups. By using a synchronous virtual space (Elluminate Live®), students are given additional opportunities to engage with the course concepts in a setting that allows them to work actively and collaboratively in small groups. Students sign up for a “problem session” in groups of no more than 24. When the students login, they enter a virtual classroom setting with a white board and the ability to text or voice chat with their peers or instructor. Students can ask questions, share documents and websites with each other and with the instructor. The instructor can invite them to write on the white board, to add to material already there or to present their own work. Students can enter “breakout rooms” where they can assemble into smaller groups and tackle specific problems or case studies. This environment also has the ability for quizzing and polling students. In these online groups, students work through case studies and problems which are then coupled to assessments done in class via personal response systems. In a pilot study of this approach, students who participated in the virtual problem sessions were more successful in learning the biology concepts in the course than those who opted out of the program. Student success was measured by survey responses as well as by examination scores in the course.
**Evaluation Methods & Results:** Problem-task implementation and outcomes were measured qualitatively through a teaching experiment in 2006, and both qualitatively and quantitatively in Fall 2008, including interviews, video of small group and whole class discussions, and pre- and post-test results from Diagnostic Question Clusters. These methods revealed that students understood and were able to apply to new situations most of the target content topics; and furthermore, evidence shows that students began to develop a way of thinking about the integration of multiple scales (organismal, cellular, & molecular) when explaining ecological phenomena.

**Dissemination Activities & Plans to Disseminate:** I have designed several problem tasks (most with multiple questions) that have been implemented by colleagues at various colleges, and this past spring one set of tasks was implemented in an AP Environmental Science course. The goal is to develop an online site for sharing the tasks with interested faculty.

**Impacts of Project or Anticipated Impact:** The impacts are two-fold: (a) for students to begin to develop the ways of thinking of biologists as a result of engaging in biology problem solving. Epistemological beliefs about biology are also affected as students begin to realize that biology is not about "memorizing facts"; and (b) for biology faculty to recognize the value of engaging students in making sense of data as an approach to helping students develop knowledge; that learning occurs when one has an intellectual need to learn, and problem-tasks can be used to create this need.

**Challenges:** (a) balancing the amount of time needed to effectively implement data-rich problem tasks while also "covering" the required content established by the department. I met with colleagues and selected the "essential" content for courses; (b) implementing the problem tasks in a lecture of 40 to 48. The administration has agreed to provide me with a student assistant in each of my lecture classes; and (c) time and money to effectively analyze all of the data collected. I have a substantial amount of interview and classroom video data to analyze and I do not currently have a grant for this project.

**Abstract**: Using Data-rich Problem Tasks to Facilitate Students’ Deep Understanding and Promote Biological Ways of Thinking—(*Department of Biology, Point Loma Nazarene University, San Diego, California*)

This study set out to explore the use of data-rich problem tasks to help introductory biology students develop a deep understanding of biological content as well as develop scientific ways of thinking such as principled reasoning. Over the past four years several problem tasks were developed and implemented in introductory undergraduate classes, both for biology majors and non-majors. Prior to Fall 2008, qualitative analysis (video analysis and student work) revealed that students understood and could apply many of the target content topics and, although resistant at first to the thinking and reasoning needed to solve the problems, students often claimed that they preferred this approach to learning by the end of the semester.

Furthermore, evidence suggests that students began developing some ways of thinking of a biologist; for example, students began integrating multiple scales (organismal, cellular, & molecular) when explaining ecological phenomena. The qualitative analysis has also revealed that students’ epistemological beliefs about biology improved. The use of Diagnostic Question Clusters in the Fall of 2008 revealed some biology concepts that students still struggle with (e.g. that matter does not turn into energy), and provided insight into next steps for instruction.
**Poster #26**

**Category:** A1  

**Primary Project or Approach:** Encouraging and Enabling Student Active Learning (Examples include Case Studies, POGIL, Clickers, Problem Based Learning)

**Institution:** Purdue University Department of Biological Sciences

**Presenter:** Nancy Pelaez  
**Email:** npelaez@purdue.edu

**Co-Presenter:** Ellen Gundlach, Purdue University Department of Statistics  
Samiksha Neroorkar, Purdue University Department of Biological Sciences  
Arlene A Russell, UCLA Department of Chemistry and Biochemistry

**Field of Interest within Biology:** General Biology

**Goals & Intended Outcome:** Both life scientists and statisticians currently see a need to emphasize experimental and quantitative aspects of biology. Pedagogical recommendations for biology and statistics instruction convince us that we can solve these problems by working together in ways that neither discipline can accomplish alone.

**Methods & Strategies:** Calibrated Peer Review assignments are used as a mechanism for presenting students with a problem and background information and then having them write about it. The student’s grade is based on both writing about and peer reviewing explanations of experimental methods and quantitative approaches in biology.

**Evaluation Methods & Results:** We developed a five-point scaled participant perception inventory with 33 items to address students’ knowledge, experience, and confidence about basic experimental and statistical concepts in a bioscience context. The instrument was used in a freshman biology lecture course during the Spring 2009 semester before and after a series of writing assignments about experimental methods and quantitative approaches in biology. Results show significant improvement in all of these areas with medium or large effect sizes and less variability in the post-test than in the pre-test for all racial and ethnicity groups in the course.

**Dissemination Activities & Plans to Disseminate:** A WIKI (http://wiki.bio.purdue.edu/stats4bio/) informs others about the materials developed and enables collaborations across departments and institutions. All assignments are shared through the CPR library, with a new version of CPR that allows faculty to share, critique, and improve CPR assignments.

**Impacts of Project or Anticipated Impact:** This project helps students in an undergraduate freshman biology lecture course learn how experimental and quantitative aspects of biology have changed along a historical continuum and introduces statistics in a manner allied to student interests in biology. The assessment of student knowledge and attitudes and perception of their own abilities is an important component of this work, and diversity issues are also being investigated. Development and refinement of an instrument that is easy to use and to interpret will add to knowledge about how to determine outcomes of projects such as this.

**Challenges:** Some students reject the idea of critiquing or being critiqued by their peers. Although in the professional scientific community, peer review is an important part of the scientific process, some undergraduate students expect an omniscient expert whose judgment they trust. The students did like the quick and detailed feedback on their work, which would not have been possible in an instructor-graded assignment for a large freshman biology lecture course. Repeated use of CPR assignments within a semester builds student confidence in what they gain from the peer-review process.
Poster #27  
**Category:** A1  
**Primary Project or Approach:** Encouraging and Enabling Student Active Learning (Examples include Case Studies, POGIL, Clickers, Problem Based Learning)  
**Institution:** Rogers State University  
**Presenter:** D. Sue Katz  
**Email:** skatz@rsu.edu  
**Co-Presenter:** Jennifer L. Kisamore, University of Oklahoma-Tulsa  
**Field of Interest within Biology:** Microbiology, Virology  

**Goals & Intended Outcome:** The goals of the current study are two-fold. First, we seek to evaluate the effectiveness of a simple manipulative on understanding of protein structure. Second, we examine whether using this manipulative enhanced calibration (i.e., did the students recognize what they did or did not understand?).  

**Methods & Strategies:** Microbiology students were divided into control and experimental groups. Student knowledge and self-assessment were measured before and after instruction. Both groups received the same initial instruction, and the experimental group worked with pipe cleaners in an additional modeling activity.  

**Evaluation Methods & Results:** Student responses were de-identified and coded before analysis. Independent samples t tests and correlational analyses used on the quantitative data; student comments were qualitatively analyzed. No significant pretest differences were found, suggesting pretest group equivalence, and no significant performance differences were found on the posttest or final exam; trends, however, were in the hypothesized directions. After instruction, calibration was significant for the experimental but not the control group. Qualitative analysis suggested students found the pipe cleaner method helpful.  

**Dissemination Activities & Plans to Disseminate:** An extension of this project is in the process of being analyzed. The strategy has been presented at several conferences (SWARM, ASM General Meeting and ASMCUE) and has been well received by other faculty members.  

**Impacts of Project or Anticipated Impact:** Pipe cleaners are simple, inexpensive objects students can manipulate to model various concepts. Student feedback suggesting the modeling was helpful as a learning tool for some students agrees with the known variety of learning styles (e.g. auditory, read-write, kinesthetic). Also, discussions with other faculty members indicate that many students may have difficulty in grasping abstract concepts and representations, perhaps remaining in Piaget’s concrete stage of learning. Such modeling may also help students to better assess their own level of mastery of concepts.  

**Challenges:** No unexpected challenges were experienced.

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Poster #28  
**Category:** A1  
**Primary Project or Approach:** Encouraging and Enabling Student Active Learning (Examples include Case Studies, POGIL, Clickers, Problem Based Learning)  
**Institution:** San Diego State University  
**Presenter:** Kathleen Fisher  
**Email:** kfisher@sciences.sdsu.edu  
**Field of Interest within Biology:** Biology Learning/Teaching
**Goals & Intended Outcome:** We are developing diagnostic tests in four areas: a revised version of Odom and Barrow’s osmosis and diffusion test, a modified version of Anderson, Fisher & Norman’s Conceptual Inventory of Natural Selection, respiration & photosynthesis (in collaboration with David Treagust), and cell division (in collaboration with Mike Smith).

**Methods & Strategies:** These tests have been deployed for four years with upper division biology majors at a large public university to assess learning gains within a programmatic assessment framework. The multiple-choice diagnostic tests use students' commonsense ideas as distractors to assess the ability of students to select a scientifically correct idea over familiar (but incorrect) popular ideas.

**Evaluation Methods & Results:** Testing large numbers of students each semester for four years has provided invaluable opportunities for refining and validating the four tests. We are testing concepts that are taught in high school and lower division courses, yet the tests are being administered to upper division students to assess their level of understanding of these basic ideas. We would hope that all biology students would achieve an in-depth understanding of these ideas by the time they are ready to graduate, but this is not the case. We seem to be seeing gains across the four semesters, but not always consistently.

**Dissemination Activities & Plans to Disseminate:** We are nearly ready to submit a paper about and to publish the osmosis and diffusion test. We hope to do the same with natural selection and perhaps respiration/photosynthesis by the end of the summer. Cell division has been particularly challenging and definitely needs more work.

**Impacts of Project or Anticipated Impact:** We anticipate that the greatest impact will follow publication and dissemination. We hope that many biology faculty will develop an interest in using diagnostic tests not for grading students but to assess their own teaching effectiveness. We’ll also encourage the use of individual diagnostic test items as "tools" (problems to be presented to students) for interactive teaching in large lecture classes. We are organizing presentations by many diagnostic test developers at the American Society for Microbiology 17th Conference for Undergraduate Educators in San Diego in June 2010.

**Challenges:** It is most challenging to develop good diagnostic test items and tests. And that challenge is minor compared to the challenge of engaging biology faculty in learning to teach for comprehension rather than memorization.

**Poster #29**  
**Category: A1**  
**Primary Project or Approach:** Encouraging and Enabling Student Active Learning (Examples include Case Studies, POGIL, Clickers, Problem Based Learning)  
**Institution:** Science / AAAS  
**Presenter:** Melissa McCartney  
**Email:** mmccartn@aaas.org  
**Co-Presenter:** Melissa McCartney, Science / AAAS  
**Pamela J. Hines, Science / AAAS**  
**Field of Interest within Biology:** Neuroscience  

**Goals & Intended Outcome:** We are brainstorming about how Science magazine can best be used in educational contexts, whether in college or in K-12. We are considering existing Science content types as well as considering what sorts of new resources to develop to make Science a useful part of the undergraduate classroom.
**Methods & Strategies:** We are asking for input from educators who might find this resource to help refine our ideas of what aspects of the resource should be developed.

**Evaluation Methods & Results:** We do not have any data yet. When we do arrive at the point where we have a useful resource, we will invite feedback from users. We will also be watching which aspects of the resource are most used, and where comments arise most often.

**Dissemination Activities & Plans to Disseminate:** This project is only just beginning. When the materials are developed, they will most likely be made available through Science’s web site.

**Impacts of Project or Anticipated Impact:** This project is only just beginning. However, we hope that the project will help faculty make the best use of leading-edge science in their classrooms.

**Challenges:** As the project is only just beginning, we have yet to find and face our challenges. No doubt there will be challenges, and we will bring as much optimism and thoughtfulness as possible to them.

**Abstract:** From Science to the Classroom

Imagine a science classroom where students are engaged and learning about the reasoning and rhetorical practices of science. Standard textbooks have been largely replaced with primary literature articles. Instead of only learning what was discovered in previous years, students are also learning what scientists do, how scientists communicate, what was discovered just last week, and where cutting edge research is headed. Impossible? Adapted primary literature (APL) retains the qualities of primary scientific literature yet adjusts the content for high-school and undergraduate students. The use of APL in the classroom introduces students to the idea that written texts are used by scientists both to construct arguments and to present these arguments for evaluation by other scientists. Current research is shifting towards discovering the best theories and approaches that use APL to encourage scientific inquiry through reading, writing, and analysis. The ultimate success of APL may lie in the way it is designed. Appropriate content, background information, and support will all need to be developed, and these resources need to be optimized for use by teachers, and by students at various levels of engagement. Science would like to become a leader in this field, and we are turning to educators for advice. Every week Science publishes a wealth of cutting edge scientific news and research articles, all of which can be combined in a variety of ways to take students from the simplest level at EurekAlert’s “Science for Kids” to the greater technical complexity of a Science Research Report. How can we best package selected resources as educational tools? How can we help teachers use our materials in the classroom? What additional resources would teachers and students find useful? We have provided examples of possible educational clusters on this poster, and are looking forward to discussing further possibilities with the science education community.

**Poster #30**
**Category: A1**
**Primary Project or Approach:** Encouraging and Enabling Student Active Learning (Examples include Case Studies, POGIL, Clickers, Problem Based Learning)
**Institution:** Spelman College
**Presenter:** Aditi Pai
**Email:** apai@spelman.edu
**Co-Presenter:** Cynthia Bauerle, HHMI Biology Department, Spelman College
**Field of Interest within Biology:** General Biology
Goals & Intended Outcome: The goal of this project was to revise the biology majors curriculum at Spelman to emphasize 1) solid grounding in contemporary foundations of the discipline, 2) development of analytical, communication and technical skills, 3) application of experimentation and hypothesis testing, and 4) learning science in an interdisciplinary context. The intended outcome was to revise Spelman’s majors curriculum to emphasize student-centered learning in an active context and to present comprehensive training in the biological sciences as a research-based discipline.

Methods & Strategies: The project took place from Spring 2006-Spring 2008, supported by undergraduate science education grant from HHMI. Broad outcomes were informed by concepts developed in Bio 2010 and local discussions about student learning objectives. Biology department faculty and staff participated in planning retreats and received release time to work in course development teams to develop four new introductory courses that were rolled out over a four-semester period. The department also restructured upper division courses to reflect an electives curriculum that elaborates on skills and concepts in the introductory core.

Evaluation Methods & Results: The department has implemented a variety of course-specific and curricular evaluations to assess the efficacy of the new curriculum. Pre-/post-assessment tools have been applied for each of the four new core courses, including pre-/post-tests, student learning self-assessment, and application of the CURE-AY. Student performance on an annual survey exam, the ETS Biology Field exam is monitored and compared to 10 years of baseline performance data for graduating biology majors. We are working to improve student tracking so that we are better able to assess long term impact of the curriculum on post-graduate training and career choices.

Dissemination Activities & Plans to Disseminate: To date, progress in creating the new curricular structure has been presented at several local science education conferences, and a manuscript describing the classroom pedagogy for one of the new courses is in review (Pai et al, 2009). A second manuscript describing the structure of the majors curriculum is currently in preparation.

Impacts of Project or Anticipated Impact: The Biology department’s curricular revision project has informed campus-wide discussions about integrated learning and student-engaging pedagogies. The first class of students to complete the new majors curriculum will graduate in 2010, and we anticipate that broad measurable impact will be observable over time. Throughout the implementation period, students reported a general high level of satisfaction and improved engagement with course activities.

Challenges: We adopted novel course-specific strategies to support the student-centered active learning approaches in core courses. The first course engages students in the process of “reading science” via case study approaches that require students to apply basic concepts to a real world situation. In the second and third courses, an active learning format replaces traditional lecture/lab division, and students engage in course concepts using a team approach during extended instructional periods offered in studio learning labs. The fourth course is organized around a semester-long project in which students work in teams to conduct research and present their results at a research conference held annually on campus.

Poster #31
Category: A1
Primary Project or Approach: Encouraging and Enabling Student Active Learning (Examples include Case Studies, POGIL, Clickers, Problem Based Learning)
Institution: Susquehanna University
Presenter: Tammy Tobin
Email: tobinjan@susqu.edu
**Field of Interest within Biology:** Microbiology, Virology

**Goals & Intended Outcome:** The goal of this course is to introduce students to the fundamental concepts and techniques of a variety of science disciplines through a somewhat unusual lens; food and cooking. Ultimately, I hope that this course will help students to make informed, ethical (and tasty!) decisions about the foods they eat.

**Methods & Strategies:** Students investigate the biology, chemistry and physics of food and cooking using a variety of team activities, investigative labs and case studies that have been developed for this course. The overall course structure is based on the Team-Based Learning Collaborative.

**Evaluation Methods & Results:** This course has not yet been formally evaluated. However, I plan to use the IDEA short form and the SALG websites to gather information about student attitudes. Susquehanna University also has a new Committee on the Central Curriculum, and I will be attending regular lunches with this group to develop course-imbedded assessment instruments.

**Dissemination Activities & Plans to Disseminate:** I currently have a web site with all course materials, and hope to write an article for the Journal of Microbiology and Biology Education as soon as I have assessment data.

**Impacts of Project or Anticipated Impact:** I expect that students’ attitudes about science will improve as they see it applied to a topic with obvious relevance to their lives. I also hope that students will learn to make more responsible and ethical decisions regarding the foods they eat as a result of taking this course.

**Challenges:** To be quite honest, my biggest challenge is classroom facilities. It is really hard to find a lab/classroom in which to teach a course where students are expected to cook and then eat their final product. Labs are out because of the eating part, so I have to teach in classrooms. Unfortunately those rooms often do not have robust enough electrical systems to handle four toaster ovens all going at once. I tend to apologize for the resulting power outages using the food we cooked during class as a bribe.

**Abstract:** ‘The Spice of Life’ is an interdisciplinary, team-based non-majors science course at Susquehanna University that helps students learn basic science concepts through a somewhat unusual lens: the food they cook and eat. Gaining a complete understanding of the science of food requires that students investigate not only its basic biological and chemical components, but also the nutritional values of its ingredients and the ways in which food handling, processing and cooking impact those values. The students also explore the amazing ways in which food production has shaped broader subjects, from human history to global ecosystems. I have developed a variety of active, inquiry-based activities and case studies specifically for this course, and use the Team-Based Learning model developed by Larry Michaelsen and colleagues to implement them.

**Poster #32**
**Category:** A1
**Primary Project or Approach:** Encouraging and Enabling Student Active Learning (Examples include Case Studies, POGIL, Clickers, Problem Based Learning)
**Institution:** Texas A&M University-Corpus Christi
**Presenter:** David Grise
**Email:** david.grise@tamucc.edu
**Co-Presenter:** David J. Grise, Texas A&M University-Corpus Christi
Courtney T. Lee, Texas A&M University-Corpus Christi

Transforming Undergraduate Biology Education: Mobilizing the Community for Change Conference Poster Abstracts
Field of Interest within Biology: Ecology and Environmental Biology

Goals & Intended Outcome: The goal is to allow incoming students to develop as students, gain skills necessary to become successful biology majors and understand biological processes that will be expanded upon in other courses. An intended outcome is that students doing well in this course will do well in subsequent science courses.

Methods & Strategies: Team learning activities and a classroom responder system were used to engage students during lecture. The Calibrated Peer Review system assists students to develop their reviewing and question answering skills. Outside-of-class mentoring sessions were offered to a subset of students.

Evaluation Methods & Results: Scores for the group portion of in-class team learning activities and exams are always higher than for the individual portion. Almost always, the group score is higher than for any individual group member. Repeated measures ANOVA indicates students become more competent reviewers over the course of the semester. An ANOVA indicates that mean final grades for students offered mentoring sessions were significantly higher than for other students and that among students offered mentoring sessions those that attended frequently had higher final grades than those that attended infrequently.

Dissemination Activities & Plans to Disseminate: Posters on aspects of this class have been presented at the Annual Meeting of the Ecological Society of America for the past two years. I have also presented at local and regional meetings. I also present a workshop during new faculty orientation at my institution.

Impacts of Project or Anticipated Impact: I have data to indicate that students doing well in our introductory biology class also do well in a sophomore-level genetics course. This is significant because students at our institution traditionally have performed poorly in the genetics course. As a result of understanding the importance of the course material and appreciating the different approaches used to deliver this material, many students have volunteered to join a program connected to our class that helps incoming students adjust to the demands of my class and college life in general.

Challenges: During the team learning assignments and exams, in many groups, the weaker students came to class unprepared to discuss the reading and relied on the high-performing student in the group to do all the work of answering questions. Many of the high-performing students made me aware of this situation. After the semester, I met with these students and they suggested an innovative and creative solution to this problem that will be implemented next year.

Poster #33
Category: A1
Primary Project or Approach: Encouraging and Enabling Student Active Learning (Examples include Case Studies, POGIL, Clickers, Problem Based Learning)
Institution: UC Davis
Presenter: Susan Keen
Email: slkeen@ucdavis.edu
Field of Interest within Biology: Evolutionary Biology

Goals & Intended Outcome: Open-inquiry or discovery-based labs that feature group work require all students to be prepared before lab begins. Preparation includes intellectual background and familiarity with methods. Our goal was to prepare 700+ students for lab each week and to assess preparatory work rapidly and with reasonable ease.
**Methods & Strategies:** Pre-labs exist in the lab manual and in an on-line format. Prelabs contain background material, thought exercises, sample calculations, and analytical questions. Student responses are submitted on-line and sent to a spreadsheet where they can be assessed by instructors.

**Evaluation Methods & Results:** We are still in the implementation phase of the new Biology series. We have collected student feedback via electronic survey, but have completed only informal surveys of instructors. We plan a more formal survey of laboratory instructors to compare present and prior preparedness, but we are hampered by the fact that this is a new course and part of a new series. Thus, we cannot compare new and old scores on the material covered. I look forward to discussion and suggestions for assessment of the pre-lab preparation.

**Dissemination Activities & Plans to Disseminate:** Poster presentation at the UC-wide 21st century Teaching Learning and Technology conference July 2008; Shared with biologists at UC San Diego, University of Illinois, and San Francisco State, as well as geography department at UCSB. Several local talks given at UC Davis; will do more in future.

**Impacts of Project or Anticipated Impact:** The impacts of the project have not been quantified, and only 3 cohorts of students have completed the series. However, observation indicates that students design and complete studies successfully and use appropriate methods; student discussion within the classroom is at a higher level than in the old series, and students give much improved presentations at the end of the 3-course series. We are searching for the means to measure this outcome and look forward to discussion on this topic.

**Challenges:** The main challenges were technical (material development, access, security, confirmed submission, but the local IT folks were extremely helpful. There were other challenges related to assessment of student work. Some instructors felt that assessment was too time-consuming, but we have improved this with instructor training. Some students were resistance to pre-lab preparation (too extensive, too time-consuming) and to deadlines for completion prior to lab attendance, and in time for assessment. Copyright rules necessitated all in-house art and text.
**Evaluation Methods & Results:** Pre-to post-test gains were compared for students in four instructors' sections prior to and after the redesign. There was a small, but statistically significant, increase in the learning gains as measured by these tests. We also embedded 10-12 common questions on the final exams for all six instructors who taught during the semester when the redesign was fully implemented. There were striking differences in performance on individual questions, but the averages across instructors on these items were essentially identical.

**Dissemination Activities & Plans to Disseminate:** We are continuing to revise the course incrementally and sharing our progress with members of the University of Arizona science education community. Our results were recently presented to the Arizona Board of Regents, who funded the redesign project.

**Impacts of Project or Anticipated Impact:** One long-term impact will be an increased focus on developing appropriate assessments to ask finer-grained questions about student learning in this large-lecture course. Another will be to serve as models as other large life sciences courses increase enrollment and need to consider educational technologies to address increased enrollments.

**Challenges:** We found that the concept of faculty academic freedom has a huge impact on teaching issues. In this course, six different instructors continued to pick and choose from among the redesign strategies in ways that worked with their conceptions of effective instruction. The non-tenure-track instructors adopted more common strategies than the tenure-track instructors. More assessment data will need to be collected to determine whether there are more subtle effects of the learner-centered strategies on student learning and performance in follow-up courses. Only with those data will we be successful in mandating significant standardization of teaching approaches in this course.

**Poster #35**
**Category:** A1
**Primary Project or Approach:** Encouraging and Enabling Student Active Learning (Examples include Case Studies, POGIL, Clickers, Problem Based Learning)

**Institution:** University of Delaware

**Presenter:** Harold White
**Email:** halwhite@udel.edu

**Field of Interest within Biology:** Molecular Biology & Biochemistry

**Goals & Intended Outcome:** In addition to the typical content goals for introductory biochemistry, Introduction to Biochemistry, seeks to stimulate attitudes of inquiry and promote independent learning through reading and discussing classic research articles on hemoglobin and sickle-cell anemia in a problem-based learning environment.

**Methods & Strategies:** Introduction to Biochemistry is taught in a problem-based learning format with research articles as problems and peers, who have previously taken the course, serving as group facilitators. The course involves significant writing assignments, concept mapping, and group quizzes using the "IFAT" strategy.

**Evaluation Methods & Results:** The course involves self, peer, group, course, tutor, and instructor evaluations which have been conducted each year for 15 years. The results show that students find the course both challenging and worthwhile. For 20 years, attendance has averaged over 95% for this class that meets at unpopular hour of 8 AM Monday, Wednesday, and Friday. Involvement of peer facilitators improved acceptance of the problem-based format and improved attendance. A required in-service pedagogy course for peer facilitators enhances questioning skills and awareness of how people learn.
**Dissemination Activities & Plans to Disseminate:** Aspects of this course have appeared in book chapters and educational journal articles. The course provides many of the examples and anecdotes presented in the Problem-based Learning commentaries that have appeared in Biochemistry and Molecular Biology Education and in ASBMB meeting workshops over the past decade.

**Impacts of Project or Anticipated Impact:** First and foremost, the course has an impact on students, many of whom acquire an interest in undergraduate research, teaching, and graduate education. Through articles, talks, and meeting workshops, the mechanics of delivering an undergraduate problem-based course in the sciences has been communicated to hundreds of faculty nationally and internationally over the past decade and a half. Personally, as a research scientist who became involved with problem-based learning, the project has had a significant impact on my career.

**Challenges:** The major challenge is in the realm of faculty development to gain faculty involvement. Student acceptance of active-learning strategies done well is not a problem. In our existing national science culture that values most highly research accomplishments, even faculty who have an interest in quality education are reluctant to devote time and energy to teaching in unfamiliar ways at a perceived risk to their research careers.

**Abstract:** Lectureless Introduction to Biochemistry: A Model for Transforming Introductory Biology Courses

A series of 8 to 10 classic research articles on hemoglobin and sickle cell anemia, presented in historical order, introduce sophomore biochemistry majors to the discipline. Each article constitutes a rich multidisciplinary problem-based learning (PBL) “problem” from which students identify and pursue those topics they need to learn or review in order to understand the article (learning issues). Most class periods in this PBL format are devoted to discussions of various learning issues within permanent groups of 3 or 4 students facilitated by a tutor who has previously taken the course. Brief descriptions of the historical context of each article and follow-up lists of instructor-generated learning issues provide the intellectual continuity and assure that students address the major conceptual issues. These issues include topics relating to ethics in the conduct of science, philosophy of science, and experimental design in addition to issues of biochemical content, biography, and history. The course, instituted seventeen years ago, incorporates many of the elements identified as important for transforming undergraduate science education in BIO 2010. It can serve as a model for designing introductory courses with an active, cooperative learning structure. Examples of classroom activities and long-term student course assessments will be presented. Supported in part by HHMI, NSF, Pew Charitable Trust, and FIPSE. Course web-site: http://www.udel.edu/chem/white/CHEM342.html.

**Poster #36**
**Category:** A1
**Primary Project or Approach:** Encouraging and Enabling Student Active Learning (Examples include Case Studies, POGIL, Clickers, Problem Based Learning)
**Institution:** University of Maryland
**Presenter:** Laura A. Cathcart
**Email:** cathcart@umd.edu
**Co-Presenter:** Kevin S. McIver, Daniel C. Stein, and Ann C. Smith, University of Maryland
**Field of Interest within Biology:** Microbiology, Virology

**Goals & Intended Outcome:** To actively and meaningfully engage students in a large enrollment course. Expected outcome: a course design that is manageable and transferable.
**Methods & Strategies:** Implementation of the active learning course framework (Smith et al., 2005, CBE Life Sci Educ) that uses case studies to engage students in lecture, lab, and online settings, group work for assignments, an instructional team of faculty and GTAs and UTAs, and an online learning management system.

**Evaluation Methods & Results:** We have found this model successful by three measures: 1) use over eight consecutive semesters, 2) transition to new faculty instructors, and 3) statistically significant increase in student learning of microbiology concepts as measured by the HPI concept inventory (Marbach-Ad et al., 2009, JMBE). Over 558 students were surveyed and scores on the inventory increased from an average score of 4.75 to 7.8 out of 18. The increase in learning was independent of the faculty instructor and was retained as indicated by pre-test scores of students entering advanced classes.

**Dissemination Activities & Plans to Disseminate:** Publication of design, methods, activities, and results in peer-reviewed journals and reporting at conferences. For example: Stewart et al., 2008, http://www.sciencecases.org/elvis/case1.asp Kramer et al., 2006, http://www.microbelibrary.org

**Impacts of Project or Anticipated Impact:** Active learning through the use of an online course management system and a collaborative teaching team can result in authentic active learning within a large enrollment course.

**Challenges:** The course depends upon the familiarity of all instructors (faculty, GTAs and UTAs) with active learning strategies. Faculty instructors are members of a teaching community dedicated to the development and implementation of active learning curricula. UTAs are enrolled in a formal for-credit course to learn teaching strategies. The limitation of the approach is in the training of graduate students in active learning approaches. There is limited time/emphasis in the graduate student curriculum for training that would best prepare them for their role as educators who understand how students learn science.

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**Poster #37**
**Category:** A1
**Primary Project or Approach:** Encouraging and Enabling Student Active Learning (Examples include Case Studies, POGIL, Clickers, Problem Based Learning)
**Institution:** University of Maryland
**Presenter:** Ann Smith
**Email:** asmith@umd.edu
**Field of Interest within Biology:** Microbiology, Virology

**Goals & Intended Outcome:** A faculty team with expertise in science research and science teaching will work collaboratively to generate research oriented teaching activities, assess their students learning, and change how they approach their shared missions of research and teaching.

**Methods & Strategies:** Faculty are working as a teaching team with a shared interest in research in Host Pathogen Interactions, and teaching in courses with related content. Working collaboratively, faculty are creating activities to engage students, and designing assessment tools including a Host Pathogen Concept Inventory.

**Evaluation Methods & Results:** The project involves faculty development and curriculum reform. Faculty development was assessed via self reporting of faculty members participating in the teaching team revealing increased engagement of faculty in teaching and curriculum reform efforts, a feeling of camaraderie and mentorship from group members. Curriculum reform has resulted in implementation
of student centered activities in the 8 courses involved in the project. Student learning is being as-
essed via the HPI Concept Inventory under development by the team. Additional outcomes of the
group work include a list of important HPI concepts.

Dissemination Activities & Plans to Disseminate: Publications and presentations at conferences. Mar-
bach-Ad et al., 2007, CBE Life Sci Educ., Marbach-Ad, et al., 2009 JMBE, Hosting workshops such as
our recent HPI Research and Teaching Workshop held June 2009 with participants from MD community
Colleges

Impacts of Project or Anticipated Impact: The HPI Teaching Team affects the learning of the 1000+
students within the 8 courses involved in the project. The faculty have been meeting as a teaching
team for 5 years and the work is changing how we teach and how we think about teaching. We are de-
vloping research oriented curricula and an assessment tool that may be used by others to engage
students in understanding the basic concepts of Host Pathogen interactions and scientific research
processes. The work of the teaching team may serve as a model for engaging research scientists in
education reform.

Challenges: Regular teaching team meetings are essential for our progress. Lunch meetings are not
disruptive allowing for consistent and high attendance. Funding for lunches was from a grant to the
University of Maryland from the Howard Hughes Medical Institute Undergraduate Science Education
Program. Moving forward requires engagement of graduate students who serve as teaching assistants.
With little time/emphasis in the graduate curriculum for development as teachers we have founded a
program with NSF funds to allow a few students to concentrate on teaching projects as they continue
to pursue lab research.

Poster #38
Category: A1
Primary Project or Approach: Encouraging and Enabling Student Active Learning (Examples include
Case Studies, POGIL, Clickers, Problem Based Learning)
Institution: University of Massachusetts
Presenter: Randall Phillis
Email: rphillis@bio.umass.edu
Co-Presenter: Zane Barlow-Coleman, University of Massachusetts
Johanna Fitzgerald, University of Massachusetts
Neil Stillings, Hampshire College
Field of Interest within Biology: Genetics

Goals & Intended Outcome: This projects describes the development a set of assessment tools for
model-based reasoning as a integral part of classroom instruction, and measures the impact of the use
of those tools for both instruction, and the development of student reasoning skills.

Methods & Strategies: We used model-based reasoning assessments in formative and summative
assessment events and measured the quantity and quality of student engagement as well as the pro-
gressive development of student reasoning skills through classroom observation and analysis of stu-
dent performance.

Evaluation Methods & Results: We evaluated student engagement during in-class reasoning events
and found that students worked effectively with each other, had on-topic arguments about the problem
and developed critical reasoning skills. We also measured impact on instruction and found that in-
structor-centered teaching decreased and student-centered activity increased such that formal lecture
dropped to only 50% of class time in a 450 student classroom. We also found that students enter the
class with significant reasoning skills and that they improved those skills through daily problem solving practice. Finally, we found that this approach can be learned and applied by multiple instructors.

Dissemination Activities & Plans to Disseminate: This work has been presented in several conferences including the Biology Leadership Conference, the CCLI conference in 2008, and at a regional Summer Institute at West Virginia University. We have also published part of this work in NABT.

Impacts of Project or Anticipated Impact: After our presentations at conferences and invited university events, we have had many faculty report that they have altered their instructional approach and developed reasoning problem development as part of their assessment plan.

Challenges: We were challenged in our observations of student reasoning in the classroom. In the large lecture hall setting, we developed an observation technique to quantify student utterances that included reasoning argumentation. We also developed sets of rubrics of student written work to measure reasoning quality.

Abstract: Assessment-driven Instruction of Model-Based Reasoning

In our approach students construct their understanding of biology by reasoning with well-established scientific models of biological systems. Our assessment tools and instructional approaches have been developed over the past 10 years at the University of Massachusetts Amherst, with the support of the Pew Center for Academic Transformation and NSF Grant Number REC-9980519.

We have adopted the definition of a scientific model described by Jim Stewart’s group: “In our view, a scientific model is a set of ideas that describe a natural process. A ‘scientific’ model so conceived can be mentally run, given certain constraints, to explain or predict natural phenomena. It is in this way that scientific models are both desirable products of scientific research and useful guides to future research.” (Cartier, Rudolph and Stewart, 2001)

Scientific models are the result of, and driving force behind, scientific inquiry in biology. (For relevant research on physics see e.g. McDermott & Redish, 1999; Clement, 1993; White & Frederiksen, 1990; Bao & Redish, 2001; for chemistry see e.g. Harrison & Treagust, 1996; Williamson & Abraham, 1995; for biology see e.g. Modell, 2000; Michael et al., 2002; Stewart et al., 1992; Cartier, 2000; Lawson, et al., 2000; for technology-enhanced learning environments see e.g. Raghavan et al., 1998; Gobert, 2000; Gobert et al., 2002). By making ‘reasoning with scientific models’ the core-learning objective, students actively master biological concepts as they engage in scientific investigation, rather than through the memorization of relatively isolated facts. As a result students begin to think of biology as an active body of theory that continues to evolve. They also learn that models are not facts, but are based on the best available evidence. Through experience, they see that they can personally contribute to the revision and improvement of scientific models.

In our instructional approach, we use questions to drive instruction rather than follow it. Question Driven Instruction is an active learning approach in which class time revolves around a question cycle where a question is posed, students work in small groups to answer it, answers are submitted and class discussion occurs. This format of instruction provides students with immediate feedback about their understanding of the material, through their interaction with peers and the professor. In our approach, we use clusters of questions ask students to reason with intricate models of real biological processes. In these problems students use the causal logic of scientific models to generate predictions or interpret data.

Biological models have rich combinatorial properties and apply to a broad range of specific situations, it is possible to writing questions that require model-based reasoning in many novel contexts. The
breath and depth of the model-based problem space allows sequences of MBR questions to be posed that exercise much of the reasoning involved in a full scientific inquiry cycle, from the generation of predictions, to the design of experiments, to the interpretation of results, to the revision of the model due to data inconsistent with the original.

**Poster #39**

**Category:** A1

**Primary Project or Approach:** Encouraging and Enabling Student Active Learning (Examples include Case Studies, POGIL, Clickers, Problem Based Learning)

**Institution:** University of Massachusetts

**Presenter:** Beverly Park Woolf

**Email:** bev@cs.umass.edu

**Co-Presenter:** Merle Bruno, Hampshire College

**Field of Interest within Biology:** Physiology & Anatomy

**Goals & Intended Outcome:** This NSF supported work teaches both human anatomy and inquiry learning (students ask questions, suggest hypotheses and provide evidence). Students solve computer medical case problems (e.g., hyperthyroidism, lactose intolerance, mold allergy) through investigations, along with information from the computer about how to approach each problem.

**Methods & Strategies:** The computer system invites students to diagnose “patients” (through interviews, medical tests, videos) and to generate hypotheses about their medical condition. Students move from one inquiry phase to another as they sort, filter, and categorized data (e.g., ask for chest x-rays, prescribe a certain drug). Structured prompts, reminders and help motivate students.

**Evaluation Methods & Results:** 1,000 undergraduates worked through some 10 medical cases in the last academic year. We looked at student data gathering activity and argument creation and found that collaboration tools enhanced the student’s argument size, (hypotheses and inferences) and the number of pieces of data collected, (e.g., observations). Students viewed each other’s notebooks containing hypotheses and evidence. Survey information indicated that students thought our tools were helpful and mentioned that tools should include the ability to specifically reference their work during discussion within the system. Students revised their hypotheses, changed their belief and generated new hypotheses based on computer advice.

**Dissemination Activities & Plans to Disseminate:** This system has been used in both college and university classes (and also with middle school students) over the last 5 years. The web-based system is entirely available to any undergraduate class and we seek additional partners. We also have experience working with publishers to disseminate software and are exploring the possibility of licensing the software.

**Impacts of Project or Anticipated Impact:** We intend that this human anatomy tutor support reflection about human anatomy, inquiry as a process and dialog as a way to collaborate. Various data collection methods (interactive images, interview interfaces) provide open-ended spaces for student exploration and help students to access and organize information. The computer identifies learning opportunities and humans peers help to improve the solution once learning opportunities are identified. We developed computer features that prompt students to compare and contrast their work and to assist each other. For example, students might be prompted to collaborate in situations where peer arguments differ, or where peers are working on the same hypothesis or collecting related data.

**Challenges:** We identified issues that keep students from fully using inquiry learning and have built software to guide these students. For example, students might zero in on one hypothesis without
closely examining others. Students relied at first too heavily on what they learned from computer in-
terviews (of the patient) and had to be coached to realize that at best this was hearsay. Students de-
veloped more refined hypothesis after they looked at each hypothesis in depth. Students became in-
terested in “red herrings” or aspects of the scenario designed to draw them away from the solution.

Poster #40
Category: A1
Primary Project or Approach: Encouraging and Enabling Student Active Learning (Examples in-
clude Case Studies, POGIL, Clickers, Problem Based Learning)
Institution: University of Minnesota
Presenter: Rob Brooker
Email: brook005@umn.edu
Co-Presenter: Deena Wassenberg, Brett Couch, and Mark Decker, University of Minnesota
Field of Interest within Biology: Cell Biology

Goals & Intended Outcome: Our goal at the University of Minnesota is to develop courses in the
biological sciences that are largely based on active learning. Our new Foundations course for incoming
Freshman and Sophomores also incorporates a team-based learning format.

Methods & Strategies: We are using a team-based approach in our new Foundations course in
which students are placed into teams and most of the in-class instruction involves projects.

Evaluation Methods & Results: Thus far, we have analyzed our new course with regard to student
grades and perceptions.

Dissemination Activities & Plans to Disseminate: We are working on incorporating more active-
learning strategies in our upper-division courses as well.

Impacts of Project or Anticipated Impact: We expect that a greater emphasis on active-learning
will better achieve our learning objectives and also will foster better student attitudes regarding their
course work.

Challenges: Thus far, my biggest challenge is grading. When most of the student work involves pro-
jects, the instructor is left with a large number of projects to grade.

Abstract: Team-based Active Learning in a Majors Biology Course in a Large Classroom Setting”

In the Fall of 2007, we initiated a new introductory biology course sequence, Foundations of Biology
for Biological Sciences Majors. This sequence consists of two semesters’ of class and lab instruction.
The format of this new course is centered on team-based active learning. Lecturing is kept to a mini-
mum and most of the students’ classroom time is spent on short-term and long-term group projects
designed to make students apply basic knowledge gained from lecture and readings. At the beginning
of the semester, the students are divided into teams of 8 or 9 to carry out their projects; students re-
main in these groups for the entire semester. The classroom is equipped with tables containing com-
puter hookups and video monitors for each group of students.

This poster concerns the second semester of our new Foundations course, which is focused on cell bi-
ology and ecology. In addition to gaining foundational knowledge in these areas of biology, the second
-semester course has a variety of other learning objectives for our students. These involve the follow-
ing: designing a simple scientific study; applying scientific knowledge in a real-world situation; devel-
opment of quantitative skills; interpretation of scientific data; peer assessment of each other’s work;
and accessing reliable scientific sources and using bioinformatics tools. The poster provides examples of how we emphasize these learning objectives and also presents data regarding the impact of team-based learning on students’ grades and their perceptions of the new Foundations course.

**Poster #41**  
**Category:** A1  
**Primary Project or Approach:** Encouraging and Enabling Student Active Learning (Examples include Case Studies, POGIL, Clickers, Problem Based Learning)  
**Institution:** University of Minnesota  
**Presenter:** Robin Wright  
**Email:** wrightr@umn.edu  
**Co-Presenter:** Mark Decker, Sue Wick, and David Matthes, University of Minnesota  
**Field of Interest within Biology:** General Biology  

**Goals & Intended Outcome:** The Foundations of Biology courses provide a team-based, collaborative learning structure that supports higher order learning outcomes, including problem solving, critical thinking, and communication.

**Methods & Strategies:** Sustained emphasis on formative assessment, immediate feedback, reflection, and group discussion to arrive at understanding; opportunities to revise work based on peer and instructor feedback; integration of university and college learning outcomes; tools to visualize the complexity of student’s understanding.

**Evaluation Methods & Results:** Each unit of instruction begins with a Learning Readiness Quiz that holds every student accountable for learning the basic concepts before class from their reading assignments. Students spend the remaining class time developing their critical thinking/problem solving skills through activities that include computer simulations, solving MCAT questions, data analysis and interpretation, and case studies. A large component of the students’ grades is based on Team Synthesis & Evaluation Projects. Students’ grades reflect their individual effort as well as the projects they prepare as a team.

**Dissemination Activities & Plans to Disseminate:** Presentations at National Meetings, including the American Society for Cell Biology and the Summer Institute for Biology Education.

**Impacts of Project or Anticipated Impact:** When compared with students who have taken other introductory biology courses, students who complete the course have higher average grades in subsequent, traditional format biology courses.

**Challenges:** none to report.

**Abstract:** Lose the Lectures, not the Learning: Team-based Learning in Introductory Biology

Undergraduates in the College of Biological Sciences at the University of Minnesota take a year-long introductory biology course with lab, Foundations of Biology. Instead of listening to lectures, each section of up to 117 students meets twice a week for two 2-hour “Concept Labs” (D. Udovich, Oregon). Interactions are facilitated by a high-tech, “SCALE-UP” (R. Beichner, NC State) style classroom with round tables, LCD monitors, and internet access. The course activities emphasize team work that promotes higher order skills (Bloom’s levels: application, analysis, synthesis, and evaluation/creation). Important features of the course include: sustained emphasis on formative assessment, immediate feedback, and group discussion to arrive at understanding; opportunities to revise work based on peer and instructor feedback; explicit integration of university and college learning outcomes; regular use of
critical reflections, concept maps and other tools to make explicit the emerging accuracy and complexity of student’s understanding. In the first semester (Biology 2002), each unit of instruction begins with a Learning Readiness Quiz that holds every student accountable for learning the basic concepts before class from their reading assignments. Students spend the remaining class time developing their critical thinking/problem solving skills though activities that include computer simulations, solving MCAT questions, data analysis and interpretation, and case studies. A large component of the students’ grades is based on Team Synthesis & Evaluation Projects. For example, to help students synthesize concepts in evolutionary biology and cell structure, teams develop a proposal for a pharmaceutical company about ideal targets for developing new antibiotics for XDR-tuberculosis. To synthesize basic genetics and evolutionary biology, students are asked to identify a problem of social value, devise solutions using genes, and analyze the evolution of those genes. This teaching model transforms the instructor’s role from “information deliverer” to “coach.” As a result, most of the instructor work involves setting up projects or problems, evaluating student work, and providing feedback on performance. In this poster, we will present strategies and tools that support the success of this course, including detailed descriptions of team projects, study guides, grading rubrics, team evaluation strategies, and intellectual property notebooks. These tools help structure this “lectureless” course into a significant learning experience for students. In addition, we also present initial analysis of student success in subsequent, more traditional courses.

**Poster #42**
**Category: A1**
**Primary Project or Approach:** Encouraging and Enabling Student Active Learning (Examples include Case Studies, POGIL, Clickers, Problem Based Learning)
**Institution:** University of Missouri-Columbia
**Presenter:** Robin Hurst
**Email:** hurstr@missouri.edu
**Co-Presenter:** Bethany Stone, University of Missouri-Columbia
**Field of Interest within Biology:** General Biology

**Goals & Intended Outcome:** We aspire to promote active learning in our students—in large classes (350+) by engaging them in activities that infuse everyday relevancy with the course content via individual and group work. Our goal was to utilize multiple teaching and learning strategies to engage students and increase learning.

**Methods & Strategies:** Our poster describes four strategies: 1) Small group work; 2) Poster sessions; 3) Video projects; and 4) Semester-long projects; that we have utilized in our classes to engage students. For each strategy, an outline, "the good, the bad and the ugly" of using each strategy, and grading rubrics are provided.

**Evaluation Methods & Results:** For evaluation of our activities, we rely upon: 1) Exam scores analysis of experimental vs. control groups of students; 2) Questionnaires collected regularly for each strategy that utilize a likert-type scale; 3) Assessment of prior knowledge in pre-tests; 4) Pre- and Post -semester tests on key concepts to assess if students are meeting our ultimate class goals; and 5) feedback from students in mid- and end-of-semester teaching evaluations.

**Dissemination Activities & Plans to Disseminate:** We have presented these instructional strategies to groups on our campus. We have also shared these teaching strategies and individual exercises with other instructors for these courses. We plan on using the online resources (e.g. Merlot) to further disseminate these methods.
Impacts of Project or Anticipated Impact: We teach non-science majors. Many come into our class intimidated by their expectations of a boring, memorization-heavy course that does not apply to their lives. By using these teaching and learning strategies we have given students an engaging means to master the material. Based on end-of-semester evaluations, students feel successful in biology, express a "positive attitude" towards biology, and feel that biology is relevant to their everyday lives. We are hopeful that this shift in attitudes will result in citizens who understand the importance of biology and the pursuit of science.

Challenges: The biggest challenge to implementing all our activities is the significant amounts of time to develop and assess them. To help with development, we exchange materials as much as possible. We have dealt with the challenge of assessment by having students work in groups as much as possible, especially in our large (350+) lecture classes and by developing simple grading rubrics. To address the challenge of taking class time to do these activities, we have gone from a traditional face-to-face format to more blended format. We use Podcasts, online videos, online tutorials, and simulations to present lecture material.

Poster #43
Category: A1
Primary Project or Approach: Encouraging and Enabling Student Active Learning (Examples include Case Studies, POGIL, Clickers, Problem Based Learning)
Institution: University of New Mexico
Presenter: Thomas Turner
Email: turnert@unm.edu
Co-Presenter: Joseph Cook, Sylvia Brunner, and William Gannon, University of New Mexico
Field of Interest within Biology: Organismal Biology

Abstract: The University of New Mexico’s URM program, called Undergraduate Opportunities (UnO), recruits students and prepares them for graduate study and a career in research. All students receive up to 3 years of intensive research training with faculty mentors from the Museum of Southwestern Biology (MSB), the Sevilleta Long Term Ecological Research (LTER) site, and the Biology Department. The Program targets sophomores, especially highly qualified underrepresented minority students, but has also accepted juniors, seniors and, most recently, a freshman who had volunteered with MSB as a high school student. Students are recruited from UNM, Diné College, Central New Mexico Community College, Southwestern Indian Polytechnic Institute (SIPI) and other nearby institutions in the Southwest. The Program uses a multi-level mentoring approach, involving students at various academic stages, including those who have transitioned successfully to graduate school. In addition to Faculty Mentors, the program includes a rotating Graduate Mentor and a Peer Mentor from the university’s Honors Program. UnO requires students to participate in seminars and other student-enhancement activities, including preparation of a research paper and presentation of results at conferences, and even co-publication. In addition, UnO participants attend potlucks at faculty homes and include their families and friends from the first day in the program, thereby extending the network of student support. During the two years the UnO Program has been operating, 4 students have graduated with a Bachelor’s degree in biology; two have already been accepted into a Master’s program. UnO currently supports 20 students – over 90% are from under-represented groups. Please visit our website at: http://www.msb.unm.edu/.
**Poster #44**  
**Category: A1**  
**Primary Project or Approach:** Encouraging and Enabling Student Active Learning (Examples include Case Studies, POGIL, Clickers, Problem Based Learning)  
**Institution:** University of North Texas  
**Presenter:** Lee Hughes  
**Email:** lhughes@unt.edu  
**Field of Interest within Biology:** General Biology

**Goals & Intended Outcome:** The goal of this project was to produce a blended course format for introductory majors biology that would provide an enhanced learning environment for students. The project sought to combine the best qualities of face-to-face and online learning to provide students with a better understanding of the content.

**Methods & Strategies:** In the new blended model, about two-thirds of the information delivery occurs through online modules. The entire class also meets once per week in a large lecture format that incorporates active learning strategies. Small group recitations meet once per week for small group activities and problem-solving.

**Evaluation Methods & Results:** As part of the evaluation of this redesigned course format, data have been collected to compare student outcomes in the redesigned sections with those of students in traditional face-to-face sections. Additional information has also been collected from student evaluations, an attitude toward subject survey, and a student assessment of learning gains. This presentation will discuss the results of this ongoing study on a blended-format freshman biology course for majors and provide an overview of lessons learned to date.

**Dissemination Activities & Plans to Disseminate:** I have given 3 presentations or posters at national meetings concerning aspects of this course redesign project. I am in the process of compiling additional data toward the preparation of a manuscript which will be submitted for publication. I am also writing a case study about this project for a book on blended learning.

**Impacts of Project or Anticipated Impact:** Students in the blended course have performed significantly better on a concept inventory than those in traditional sections and have a higher success rate based on course grades. They rate the redesigned course highly on a learning gains survey. Approximately 80% of these students would choose the blended-format course if they had they had to choose again. Student evaluations also show high student satisfaction with this course. However, no longitudinal data is available to show if this format provides additional benefits to these students in subsequent courses.

**Challenges:** No significant challenges were encountered in the course redesign process. One issue relating to class length for the one lecture meeting per week was discovered in the pilot offerings of the course. As a result, future semesters utilized an 80 minute class period rather than a 50 minute meeting time in order to provide additional time for class activities.

**Abstract:** Blended Learning in an Introductory Biology Course

An introductory biology major’s course was redesigned in a blended format (combination of face-to-face and online teaching activities) with the intent of improving student learning and success. Students met each week with the instructor for an hour and a half in a large lecture hall (over 100 students) and in smaller groups (25-30) with a graduate student teaching assistant for an hour-long reci-
Some 40% of the course material was delivered through the lecture, with the remaining content given in online course modules. Lectures were modified to include active-learning components and to focus on processes and concepts rather than definitions. The recitations were extensively redesigned to include group activities and active learning strategies. Weekly online lessons provided activities, discussions, external website readings, or homework assignments to reinforce the material. As part of the evaluation of this redesigned course format, data have been collected to compare student outcomes in the redesigned sections with those of students in traditional face-to-face sections.

Additional information has also been collected from student evaluations, an attitude toward subject survey, and a student assessment of learning gains. This presentation will discuss the results of this ongoing study on a blended-format freshman biology course for majors and provide an overview of lessons learned to date.

**Poster #45**

**Category:** A1

**Primary Project or Approach:** Encouraging and Enabling Student Active Learning (Examples include Case Studies, POGIL, Clickers, Problem Based Learning)

**Institution:** University of Pittsburgh

**Presenter:** Laurel Roberts

**Email:** laurelb@pitt.edu

**Field of Interest within Biology:** Physiology & Anatomy

**Goals & Intended Outcome:** To enhance learning by enhancing communication. I wanted my students to use the lecture material as a base for making "real world" connections while honing their communication skills.

**Methods & Strategies:** Groups of 2-3 students chose an organ system of the body. Their task was to research a disease related to that system and design an informational pamphlet (and a brief classroom presentation) about their disease.

**Evaluation Methods & Results:** The evaluation was based on: A group rubric, signed by each member detailing who performed each task (5 points) The brochure: resources cited, background information, disease description (6 points) The presentation: preparation, content, style (9 points) Extra credit was offered for exceptional work.

**Dissemination Activities & Plans to Disseminate:** I was so pleased with the level of creativity and engagement from students (especially those who had not done well on the exams) that I plan to repeat the project, start it earlier in the semester and hopefully add an assessment tool.

**Impacts of Project or Anticipated Impact:** I know from their comments that my students gained a deeper understanding of the material. I think that they became more motivated to learn the material.

**Challenges:** One group created a large cardboard toilet as a display site for their photos on colon polyps. At the end of the presentation, I didn't know what to do with it!
Poster #46  
Category: A1  
**Primary Project or Approach:** Encouraging and Enabling Student Active Learning (Examples include Case Studies, POGIL, Clickers, Problem Based Learning)  
**Institution:** University of Southern California  
**Presenter:** John Walsh  
**Email:** jwalsh@usc.edu  
**Co-Presenter:** Greg Misiaszek, Michelle Riconscente, and Jerry Sun, University of Southern California  
**Field of Interest within Biology:** Neuroscience  

**Goals & Intended Outcome:** To develop a simple method for creating multimedia educational materials that allow professor to teach and students to learn basic principles in science, while at the same time exposed them to the research that leads to scientific discovery.

**Methods & Strategies:** We developed an on-line interface that allows for easy loading of information (assets) into an on-line course. The interface is designed so any professor can create a web-based course from their desk top.

**Evaluation Methods & Results:** We have integrated the use of an outside vendor, Qualtrex, into the on-line educational tool to facilitate student evaluation of the educational tool. We also integrate an online quiz in each chapter for students to assess their performance relative to their peers. The course will be used for the 1st time in fall 209.

**Dissemination Activities & Plans to Disseminate:** Multiple courses at USC will be using the on-line educational tool we developed for neuroscience and we have recruited a number of professor across the country to use it as well. These professors will serve as ambassadors for disseminating the tool and our staff will also approach programs across the country for using the tool.

**Impacts of Project or Anticipated Impact:** We anticipate the tool will enhance learning through the use of animations and interactive exercise in lectures. Students will also be able to see the kind of research being performed in laboratories that are linked to material presented in the chapter and hopefully, from this exposure, consider performing research in these laboratories as an undergraduate.

**Challenges:** It does take some time to get the permission to use images and multimedia developed outside our university. The best method for dealing with this is prepare ahead of time and make sure you follow copyright law.

**Abstract:** Online Interface for Simplifying Course Development and Assessment: Dynamic Flash-based Course.

We developed an interface that simplifies the development of multi-media internet-based courses in science. The internet course is designed for use by the professor in class instead of traditional Powerpoint methods of instruction. The courses we developed are in neuroscience, but the method of course development applies to all subjects. The interface feeds into pre-designed templates that allow for rapid non-linear loading of information (assets). The interface makes internet course updating and redesign easy. Our experience indicates that numerous animations and interactive exercise exist in cyber space and that they can easily be incorporated into courses as links. Directions are provided for students via scrolling text and narrations uploaded as MP3 files (assets). Learning assessment can be included as quizzes that automatically dump results into class register files for students and faculty to use monitor learning. Student and faculty assessment of the utility of the on-line educational tool is easily obtained from integrated assessment profiles developed through the use of an outside vendor, Qualtrex.
**Poster #47**  
**Category:** A1  
**Primary Project or Approach:** Encouraging and Enabling Student Active Learning (Examples include Case Studies, POGIL, Clickers, Problem Based Learning)  
**Institution:** University of Washington  
**Presenter:** Scott Freeman  
**Email:** srf991@u.washington.edu  
**Co-Presenter:** David Haak and Janneke Hille Ris Lambers, University of Washington  
**Field of Interest within Biology:** Research on student learning  

**Goals & Intended Outcome:** In an effort to improve performance in an introductory biology course for majors, we instituted weekly, written practice exams that were peer graded. The goal of the research was to determine whether students benefited more from doing these practice exams individually versus in groups.  

**Methods & Strategies:** During two quarters, we randomly divided a large-enrollment class into two groups. Half the students did the weekly practice exam by themselves; half did the same exercise at the same time as a member of a 4-person group that included 1 high-risk student, 2 medium-risk students, and 1 high-achieving student.  

**Evaluation Methods & Results:** We used a maximum likelihood approach to compare how students who practiced individually versus in groups performed on actual exams, as a function of how well students were expected to do in the course. (This expectation was based on a "predictor score" computed from college GPA at the time of entering the course and SAT-verbal score.) Overall, there was no difference in performance on actual exams, based on individual versus group practice. High risk students did best if they practiced individually, however, while high-achieving students did best if they practiced in groups.  

**Dissemination Activities & Plans to Disseminate:** We have presented this research as a poster at several teaching workshops and have submitted a paper.  

**Impacts of Project or Anticipated Impact:** Our data suggest that group work is not a panacea for improving performance by high-risk students, and that individual practice might have greater benefits for high-risk students--at least in the context of doing practice exam problems under time pressure. In addition, our data support other research suggesting that high-achieving students may get a disproportionate benefit from some types of group work. Based on these results, we have instituted weekly, peer-graded practice exams, done individually, as a normal feature of our large-enrollment introductory course for majors.  

**Challenges:** The results were opposite our predictions. We respect the data.  

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**Poster #48**  
**Category:** A1  
**Primary Project or Approach:** Encouraging and Enabling Student Active Learning (Examples include Case Studies, POGIL, Clickers, Problem Based Learning)  
**Institution:** University of Wisconsin - River Falls  
**Presenter:** Mark Bergland  
**Email:** mark.s.bergland@uwrf.edu  
**Field of Interest within Biology:** Bioinformatics
Goals & Intended Outcome: Case It! is an NSF CCLI-sponsored, international collaborative project involving faculty in the departments of Biology and Teacher Education. The goal of the Case It! project is to enhance case-based learning in high school and university biology courses via molecular biology computer simulations and Internet "poster sessions".

Methods & Strategies: The goal of the Case It! project is to enhance case-based learning in high school and university biology courses via molecular biology computer simulations and Internet "poster sessions". Our previous grants focused on the development of case studies involving DNA analysis (PCR, restriction enzyme digestion, electrophoresis, Southern blot, dot blot) and protein analysis (ELISA, Western blot), with an emphasis on human genetic and infectious diseases. Students first play the roles of laboratory technicians as they analyze sequences associated with particular cases and construct web page posters giving results of laboratory testing. They then play the roles of family members and genetics, HIV, or other health care counselors as they ask and answer questions concerning these tests.

Evaluation Methods & Results: The results of several years of class testing demonstrated that the project improved student learning of biology concepts and encouraged students to examine related ethical issues. Methods involved pre- and post-testing and focus-group interviews, most recently with students at the University of Wisconsin-River Falls, North Carolina A&T State University, and the Inter American University of Puerto Rico. This data is currently being analyzed by Bjorn Wolter, a PhD candidate at Michigan State University, under the direction of Mary Lundenberg.

Dissemination Activities & Plans to Disseminate: A new version of the Case It simulation with bioinformatics capabilities (v6.0) will be released in August, 2009. Like previous versions of the simulation, educators will be able to download v6.0, free of charge, from the Case It website (http://caseit.uwrf.edu). Educators from almost all states in the U.S. and many foreign countries have downloaded previous versions of Case It software.

Impacts of Project or Anticipated Impact: The Case It project has had a substantial impact on undergraduate biology education, as documented by extensive use in the U.S. and abroad, along with testimonials from educators who have used the software with students. This documentation is provided in annual and final reports for the project.

Challenges: Communications with collaborators outside the continental U.S. are sometimes problematic, but we have been able to resolve these through annual mini-conferences, and periodic Skype conference calls.

Abstract: Case It! is an NSF CCLI-sponsored, international collaborative project involving faculty in the departments of Biology and Teacher Education. The goal of the Case It! project is to enhance case-based learning in high school and university biology courses via molecular biology computer simulations and Internet "poster sessions". Our previous grants focused on the development of case studies involving DNA analysis (PCR, restriction enzyme digestion, electrophoresis, Southern blot, dot blot) and protein analysis (ELISA, Western blot), with an emphasis on human genetic and infectious diseases. Students first play the roles of laboratory technicians as they analyze sequences associated with particular cases and construct web page posters giving results of laboratory testing. They then play the roles of family members and genetics, HIV, or other health care counselors as they ask and answer questions concerning these tests. The results of several years of class testing demonstrated that the project improved student learning of biology concepts and encouraged students to examine related ethical issues. The goal of the current grant (2008-2012) is to add connections from the Case It software to bioinformatics tools, to facilitate open-ended research questions.
Poster #49
Category: A1
Primary Project or Approach: Encouraging and Enabling Student Active Learning (Examples include Case Studies, POGIL, Clickers, Problem Based Learning)
Institution: University of Wisconsin-Madison
Presenter: Lillian Tong
Email: tong@wisc.edu
Co-Presenter: Robert L. Jeanne, Amber L. Robertson, and David L. Hatfield, UW-Madison
Field of Interest within Biology: General Biology

Goals & Intended Outcome: 1.) Increase relevant communication between instructors and students; 2.) Increase student writing without overburdening instructors; 3.) Provide a tool for instructors to track/study/talk about student learning; and 4.) Use on-line tools to address teaching/learning and communication challenges

Methods & Strategies: Biology instructors of large courses are emphasizing higher-order thinking skills, yet students display their understanding and receive feedback mainly through multiple choice questions. We are developing and testing a Moodle (open source) tool for faculty to give semi-personalized feedback to short responses to questions. Our process of development and dissemination promotes cross-instructor communication about student learning, implementation strategies, and higher-order learning goals within biology and STEM.

Evaluation Methods & Results: We are using student pre-post surveys and focus groups with students, faculty, and coordinators. The tool was introduced Spring 09. No conclusions yet can be drawn from student data due to low response-rates and low "dosage". Instructor feedback confirmed that a range of implementation strategies must be developed to accommodate different levels of acceptable instructor "pain."

Dissemination Activities & Plans to Disseminate: An Intro physics course, chemistry course, Bio-core course will help develop new enhancements and uses. Developers of this and other tools in Moodle at UW-Madison (case-based learning module, easy math editor, skill-builder tool) coordinate and share. Moodle is open-source and tools will be available to all.

Impacts of Project or Anticipated Impact: Anticipated impacts include increased engagement of students with difficult course material, increase engagement with the course through student-instructor interactions, more thorough achievement of higher-order learning objectives, more intimate gauging of student understanding by instructors. In addition communication among instructors teaching the same subject in IntroBio and increased cross-STEM communication about higher-order thinking skills of students have already been affected. Collaborating on developing ways to implement the tool have promoted communication about ways of teaching science.

Challenges: Gauging how much additional time ("pain") instructors are willing to take on to utilize the tool was difficult, given the large numbers of instructors in this team-taught course. We also did not anticipate their reluctance to only reply to a subset of students. Other instructors will be experimenting with the broad range of options available for giving feedback and we will evaluate effectiveness.
Poster #50
Category: A1
Primary Project or Approach: Encouraging and Enabling Student Active Learning (Examples include Case Studies, POGIL, Clickers, Problem Based Learning)
Institution: University of Wisconsin-Madison
Presenter: Lillian Tong
Email: tong@wisc.edu
Co-Presenter: Robert L. Jeanne, UW-Madison
Field of Interest within Biology: General Biology

Goals & Intended Outcome: Teams of graduate students and faculty/staff create materials to address specific student learning challenges in an introductory biology course. Participants apply science research skills to their teaching, consider issues of diversity, and learn to productively use learning community to enhance learning.

Methods & Strategies: Teams from STEM disciplines ....to instructional materials design. Participants gain knowledge from discussing readings and exchanging feedback on materials being developed in a learning-community environment.

Evaluation Methods & Results: Course evaluation data, collected by survey at both the course level and the program level, suggest that participants 1) learn from having graduate students and faculty/staff work together; 2) meet the objectives of the Delta Program, and 3) apply their knowledge to the development of instructional materials.

Dissemination Activities & Plans to Disseminate: A course manual was disseminated through CIRTL (Center for Integration of Research, Teaching and Learning). The rotation of co-instructors from diverse disciplines has allowed for continual adaptation of the approach. The Introbio-focused course was developed as a pilot and has not yet been disseminated.

Impacts of Project or Anticipated Impact: Peer-reviewed materials developed by diverse teams have enhanced student learning and are continually improved based on iterative implementation in the STEM courses. Participants in the course have applied their new knowledge and skills to the development of additional instructional materials. Lastly, the course continues to foster a culture of discussion about teaching and learning that extends beyond the course itself. Faculty and students alike speak of the inspiration the course gave them to develop learning communities in their own departments.

Challenges: The biggest challenge is the limited time frame as one semester is too short for identifying the teaching/learning problem and creating materials to address it. Moreover, integrating the individual learning objectives of the participants to the overall course objectives is challenging.

Poster #51
Category: A1
Primary Project or Approach: Encouraging and Enabling Student Active Learning (Examples include Case Studies, POGIL, Clickers, Problem Based Learning)
Institution: University System of Maryland
Presenter: Nancy Shapiro
Email: nshapiro@usmd.edu
Co-Presenter: Philip Sokolove, University of Maryland Baltimore County
David May, University System of Maryland
Field of Interest within Biology: General Biology
Goals & Intended Outcome: The broad goal of the Vertically Integrated Partnerships K-16 project (an NSF Math Science Partnership grant) is to improve high-school and undergraduate science education in the partner institutions, in terms of student achievement, teacher and faculty development, curricular reform, and new prospective science teachers. This poster focuses on the curricular reforms developed by faculty learning communities.

Methods & Strategies: Faculty learning communities developed at all four of our degree-granting partner institutions, each with a different structure and style. In most cases, project leaders and/or campus leaders invited interested science faculty to meet together and discuss inquiry instruction. The faculty's self-leadership and its connection with K-12 teachers were encouraged and supported.

Evaluation Methods & Results: Several data sources were used, including course artifacts such as lesson plans, interviews and surveys with faculty and students, and student achievement data. A case-study approach was used for each campus's learning community and in some cases for subsets of communities. It was found that faculty learning communities were instrumental in the curricular reform efforts of individual faculty or pairs of faculty. Several new inquiry-based courses were developed from scratch, and many more existing courses were modified with new lesson plans, lab manuals, textbooks, assessments, or pedagogical strategies. Most of these reforms have been sustained after the project's grant funding ceased.

Dissemination Activities & Plans to Disseminate: Several faculty participants and project leaders have written about or presented on the nature of these faculty learning communities and the reforms that have come from them. We plan to pursue this strategy further and also publish some of the findings in peer-reviewed journals.

Impacts of Project or Anticipated Impact: As stated above, most of the reforms generated by the faculty learning communities have remained beyond the period of grant funding. In addition, some of the learning communities themselves have remained or grown to include new faculty from science or other STEM fields. We expect that the success of these learning communities will show that faculty work on their own teaching, particularly when it involves K-12 partners, is important for higher education in STEM fields, and that faculty will be increasingly rewarded for this work.

Challenges: As with science faculty at many institutions, the pressure to focus their time and energy on research can be very strong with our faculty participants. To help them take time for working on curriculum and pedagogy with each other and with K-12 teachers, we had some success with a combination of awarding stipends or funding temporary course buyouts, and meeting with institution administrators or other influential stakeholders to emphasize the nature of our partnership. In many cases faculty were their own best advocates.

Poster #52
Category: A1
Primary Project or Approach: Encouraging and Enabling Student Active Learning (Examples include Case Studies, POGIL, Clickers, Problem Based Learning)
Institution: UT Austin/IUPUI
Presenter: Sarah Lang
Email: slang@brynmawr.edu
Field of Interest within Biology: General Biology

Goals & Intended Outcome: The goals of the UT Teaching Teams Program are to: 1) provide structured opportunities for students to engage in more active and collaborative learning; and 2) provide
instructional support to upper-division biology and biochemistry courses that have historically high attrition rates.

**Methods & Strategies:** This program establishes peer-assisted study groups that are facilitated weekly by volunteers currently enrolled in the course. These volunteers meet weekly with the faculty member to discuss content and agenda for upcoming study groups.

**Evaluation Methods & Results:** Evaluation methods include: mid-semester observations, statistical analysis of program participation and grade outcomes, and end-of-semester evaluations of students and faculty connected to the program. Study group participants earn significantly higher grades and/or are significantly less likely to drop or fail the course than non-participants. Regular participants report that the participation in study groups has given them structure for studying, improved their understanding of and ability to explain course material, and created a much-needed opportunity to network with other students.

**Dissemination Activities & Plans to Disseminate:** Each semester, we send course statistics and summarized student evaluations to each of the participating faculty members. We also send summarized data as part of the Center’s Annual Report to the VP of Student Affairs, Lastly, we recently presented results about students’ motivation at the 2009 AERA meeting.

**Impacts of Project or Anticipated Impact:** We measure impact of the program primarily by looking at the study group facilitator and faculty outcomes. Study group facilitators report that their participation has improved their understanding of and engagement with the course material and improved their communication and group facilitation skills. Due to the regular feedback from study group facilitators, faculty feel they can better gauge student understanding and can thus provide more effective just-in-time assistance. In addition, some have used this regular feedback to help assess instructional changes they have implemented.

**Challenges:** Our biggest challenge has been the lack of appropriate classroom space on campus. We have dealt with this by only scheduling study groups in late afternoon/evening and requesting the rooms as early as possible. Scheduling the study groups is also difficult because most of the students we serve are upper-division science students who are typically over-extended due to research and employment commitments. We have dealt with this by utilizing a pre-semester survey that has the dual function of advertising the study groups and acquiring information from students about the best times to offer study groups.

**Poster #53**  
**Category:** A1  
**Primary Project or Approach:** Encouraging and Enabling Student Active Learning (Examples include Case Studies, POGIL, Clickers, Problem Based Learning)  
**Institution:** Wake Forest University  
**Presenter:** A. Daniel Johnson  
**Email:** johnsoad@wfu.edu  
**Field of Interest within Biology:** General Biology

**Goals & Intended Outcome:** Train graduate students to: use a variety of empirically proven teaching methods; think more broadly about how to develop undergraduate students’ content knowledge and thinking skills; use both formative and summative assessment to evaluate student learning.

**Methods & Strategies:** Our department uses a combination of methods. All TAs attend a general orientation prior to teaching that focuses on learning theory and empirical practices. Subsequently,
TAs are observed routinely (3+ times/semester) as they teach, then formally evaluated by their students. TAs interested in learning more can take formal coursework (BIO783 in particular) in the theories and practice of teaching and learning.

**Evaluation Methods & Results**: We conduct online qualitative and quantitative evaluation of all TAs in the 6 courses they supervise. Students complete a survey about their TA and overall course experience. Summaries are generated for each course section, each TA, all TAs in one course, and overall for the semester. Data are used internally for providing TAs with individualized coaching; pooled data are shared with all TAs as benchmarks for self-assessments. TAs can request their data be released for letters of reference for faculty positions. The CASH Pyramid model used in our BIO783 course will be assessed beginning Spring 2010 using: 1) a pre/post survey of knowledge gains; 2) pre/post-course assessment of instructional practices; 3) administration of the Instructional Methods Inventory (IMI; Bohrer, 2008)

**Dissemination Activities & Plans to Disseminate**: Routine TA assessments are not disseminated externally except when requested by the TA. The CASH Pyramid visual model of learning described in the "BIO783" project was only recently developed, so data on its effectiveness are not yet available.

**Impacts of Project or Anticipated Impact**: TAs consistently rate our department's program for teaching evaluation and coaching as effective in helping them develop a more reflective view of their teaching practice, and for identifying and targeting specific areas needing improvement. Post-secondary institutions who have hired our graduates have regularly praised our students' effectiveness and preparation for teaching undergraduates. In evaluating our BIO783 course, several former participants have proposed or implemented courses they developed as final projects at other institutions. We expect the evaluation in Spring 2010 will show participants have a greater understanding of the learning process overall, of specific factors that facilitate or impede learning, and how they can manage these factors as part of routine teaching practices.

**Challenges**: Our main challenges in TA evaluation and coaching are: 1) finding sufficient time to observe many TAs repeatedly; 2) normalizing quantitative scores, which vary considerably, across semesters. The former was resolved by reducing total visit time but increasing frequency. The latter was addressed by adding scored items to the TA assessment that should co-vary, and by normalizing TAs' scores to ratings of established labs (changes in lab ratings indicates students are scoring all aspects of the lab program higher or lower than usual.) For the BIO783 course we were surprised at the strong resistance that many graduate students already had against active learning. Our solution was to present papers supporting the efficacy of active learning in a journal-club style discussion.

**Abstract**: A Learner-Oriented Model for Training Future Undergraduate Science Instructors

Students retain and apply knowledge more effectively when taught using a variety of active instructional methods. Yet graduate students and new faculty often over-rely on lecture and resist using other techniques. Published and anecdotal evidence suggest three reasons: 1) novice instructors lack personal experience with other methods; 2) they lack a cognitive framework for selecting or implementing alternatives; 3) they have not yet learned relevant pedagogical principles upon which to base such choices. We developed a 1-semester graduate course, “BIO783: Instructional Methods” to address #1; within that context, course participants devised a simple model that addresses the other two barriers to effective instruction.

In BIO783, course participants collaborate to develop a new general biology course using an outcomes-oriented approach to course design. Each participant then leads one class session from the course on a topic outside his or her area of research expertise. Through these experiences, participants learn: basic principles of constructivist learning theory; a variety of empirically proven, active instructional
techniques; and several formative, summative, and normative assessments. For a final project (which is intended for a teaching portfolio), participants can develop a proposal for a course in their area of specialty or a lab unit that emphasizes active learning. Participants also can propose alternative projects, which must be approved by their peers in the course. Final projects are evaluated by the course instructor and other participants, then are returned with suggestions for improvements.

While these course activities helped resolve experience issues (i.e., # 1 above), most participants still struggled to construct a workable mental model of the learning process and key elements that affect it (#2, 3). Over the course of 2 years, BIO783 participants devised a simple visual model for categorizing the initially overwhelming volume of published literature, called the CASH Pyramid. It posits four key elements to learning: Content knowledge, Attitudes, Skills, and Habits of mind. This model has proven very useful because it was developed by novices in the field of pedagogy rather than content experts. It emphasizes the role of learners as active participants in the process, not passive recipients. It also provides novice instructors with a framework for planning future courses. Finally, the CASH Pyramid encourages novice instructors to assess their teaching effectiveness from a metacognitive perspective.

**Poster #54**

**Category: A1**

**Primary Project or Approach:** Encouraging and Enabling Student Active Learning (Examples include Case Studies, POGIL, Clickers, Problem Based Learning)

**Institution:** Washington University in St. Louis

**Presenter:** Thomas Woolsey

**Email:** woolseyt@wusm.wustl.edu

**Co-Presenter:** Lawrence Salkoff, Washington University in St. Louis

**Field of Interest within Biology:** Neuroscience

**Goals & Intended Outcome:** To teach the fundamentals of nerve cell function, brain development and the integrated functional and anatomical organization of the nervous system.

**Methods & Strategies:** Interactive and dynamic lectures provoking exchange between students and faculty. Work books and other tools to guide practice to enforce concepts. Problem sets to focus on content and ideas. There are 28 lectures and 12 discussion sessions. Currently there are 6 graduate/postdoctoral teaching assistants.

**Evaluation Methods & Results:** 1) Scores on two exams constitute 60% of the final grade; performance on problem sets 40%. The former are composed by faculty; the latter by graduate and postdoctoral TA's. These are compared from year to year. 2) Course assessment forms that are administered by the institution. 3) Post course informal contacts with students.

**Dissemination Activities & Plans to Disseminate:** Course materials are updated annually on the course web site [http://artsci.wustl.edu/~sdanker/index.html]. In many areas these constitute original papers and other items that students are expected to use to understand the biological bases for broad conceptual themes.

**Impacts of Project or Anticipated Impact:** The impacts are derived from both hard data and anecdotal feedback.
Poster #55
Category: A1
Primary Project or Approach: Encouraging and Enabling Student Active Learning (Examples include Case Studies, POGIL, Clickers, Problem Based Learning)
Institution: West Chester University
Presenter: Maureen Knabb
Email: mknabb@wcupa.edu
Field of Interest within Biology: Physiology & Anatomy

Goals & Intended Outcome: This project was conducted to evaluate whether incorporation of cases encouraged the development of integrative thinking in physiology. Additional questions included: 1) Does the delivery format affect the level of questions that students generate?

Methods & Strategies: The instructor developed 6 cases that related to the course content. Case delivery alternated between the in-class and an online format. In the beginning of the semester, students generated questions and the instructor served as a facilitator to help design appropriate questions. As the semester proceeded, the instructor gave students the freedom to generate their own questions.

Evaluation Methods & Results: Assessment was based on written group responses to the student-generated questions, instructor-generated multiple choice exam questions, and student perceptions of their learning. The end-of-semester survey indicated that all students enjoyed using case studies and an online format was slightly preferred over in-class (53%). Some students favored the news-based cases (33%) compared to invented cases and the majority (80%) preferred constructing their own questions. Most students (83%) agreed that case studies extended their understanding of course content and encouraged inter-system as well as interdisciplinary thinking.

Dissemination Activities & Plans to Disseminate: These results indicate that case studies can be incorporated successfully to develop integrative thinking in physiology and students enjoy the challenge of identifying and answering their own questions.

Impacts of Project or Anticipated Impact: It is challenging to create inter-system and interdisciplinary thinking in undergraduate courses. Case studies can be developed to encourage and stimulate integration of understanding within and beyond course content. Students enjoy addressing their own questions and working cooperatively in either and in-class or an online format.

Challenges: Students prefer authentic stories but it is difficult to identify appropriate cases that link relevant course content. Literature review can often be used to identify novel links and effective stories can be created to encourage integrative thinking.

Poster #56
Category: A1
Primary Project or Approach: Encouraging and Enabling Student Active Learning (Examples include Case Studies, POGIL, Clickers, Problem Based Learning)
Institution: West Chester University
Presenter: Maureen Knabb
Email: mknabb@aol.com
Field of Interest within Biology: General Biology

Goals & Intended Outcome: Incorporating the inquiry process into large enrollment introductory biology courses is challenging due to the large number of lab sections and multiple instructors. We
have developed a novel strategy to embed inquiry into traditional lab exercises for both biology major and non-major students.

**Methods & Strategies:** Students work in groups to learn a particular skill during the lab and apply it to lecture material. After completion of the experiment, students are presented with a short scenario in which they must use both the technical skills developed during the lab and inquiry processes to answer the problem.

**Evaluation Methods & Results:** To complete the inquiry-based challenge, student groups must 1) formulate a testable hypothesis, 2) design and conduct an appropriate investigation, 3) collect, analyze and present the data from their experiment, and 4) reflect on their original hypothesis. In an open-ended questionnaire, 90% of students identify inquiry challenge experiments as ones which they "had an opportunity to design an experiment".

**Dissemination Activities & Plans to Disseminate:** This work has been presented at both local and national scientific conferences, such as NSTA, and has led to the publication of a specific inquiry challenge activity in the American Biology Teacher.

**Impacts of Project or Anticipated Impact:** Inquiry-based challenges have been used successfully in our large enrollment (greater than 350 students/ year) introductory biology course for both majors and non-majors for 5 years. The number and variety of challenge activities have continued to grow throughout this time.

**Challenges:** Due to the large turnover in lab instructors in these large enrollment courses, it is necessary to explain the process and expectations for the students on a regular basis. Weekly lab meetings are necessary to address this problem. Instructors need to understand how to evaluate the assessment by providing them with specific examples of different qualities of student work.

**Poster #57**
**Category:** A2

**Primary Project or Approach:** Enhancing student learning through use of biological technologies (Microscopy and other visualization techniques, mass spectrometry, microarrays)

**Institution:** Johns Hopkins University

**Presenter:** Joel Bader

**Email:** joel.bader@jhu.edu

**Co-Presenter:** Jef Boeke and Srinivasan Chandrasegaran, Johns Hopkins University

**Field of Interest within Biology:** Synthetic Biology

**Goals & Intended Outcome:** Train a cadre of students excited about biology and biotechnology through a hands-on team effort to create a yeast cell with synthetic DNA.

**Methods & Strategies:** The Build-a-Genome teaching lab is a cross between a one-room schoolhouse and a biotech startup. Students of all backgrounds go through a start-of-semester boot camp in synthetic biology and bioethics, and then are unleashed with keys to the lab and a mission to synthesize DNA.

**Evaluation Methods & Results:** During the semester we track productivity and innovation of students. Informally we observe higher retention and excitement about biological and bioengineering research.
Dissemination Activities & Plans to Disseminate: All course materials are freely distributed through the course website (see www.baderzone.org) and we are assisting other schools to reproduce the course.

Impacts of Project or Anticipated Impact: Recruit and retain students in biology, biotechnology, bioengineering, and bioethics.

Challenges: We had all the standard road bumps for a new laboratory course, with additional challenges: locating lab space available for students 24/7; obtaining equipment on the cheap; adapting open-source courseware for use as an electronic notebook for students; developing dual use education / research software infrastructure.

Poster #58
Category: A2
Primary Project or Approach: Enhancing student learning through use of biological technologies (Microscopy and other visualization techniques, mass spectrometry, microarrays)
Institution: Lansing Community College
Presenter: Melinda R. Wilson
Email: mindy.wilson@lcc.edu
Co-Presenter: Thomas L. Deits, Lansing Community College Christel Marschall, Lansing Community College
Field of Interest within Biology: Multidisciplinary/Nanotechnology

Goals & Intended Outcome: Nano-Link has as its goal the dissemination of curriculum related to nanotechnology for secondary and higher education in the Upper Midwest region. Nano-Link will develop multidisciplinary nanotechnology programs, including bionanotechnology, and disseminate nanotechnology curriculum throughout the region.

Methods & Strategies: As Nano-link develops, it will serve as a hub linking educators who want to bring nanotechnology learning to their schools, whether for workforce development, curriculum enrichment, or to establish new courses, certificates or degree programs. Nano-link will also help support professional education of educators in nanotechnology.

Evaluation Methods & Results: As an NSF ATE Regional Center, Nano-Link is evaluated annually by NSF through their reporting process. Nano-Link reviews its own activities with biweekly telephone conferences and quarterly meetings. A detailed workplan has been developed and each partner has specific objectives associated with their participation. A National Visiting Committee will convene annually to assess progress and make recommendations. An Industry Advisory Board will perform the same function from the perspective of our progress in meeting workforce needs. The first annual report of our results is presently in preparation.

Dissemination Activities & Plans to Disseminate: Each year, 2 secondary school educators from Michigan will be selected to attend a full week nanotechnology education workshop provided by Northwestern University, all expenses paid by Nano-link. Additionally, Nano-link will be a resource for curriculum and will sponsor local professional development activities for educators throughout the region.

Impacts of Project or Anticipated Impact: The first two of eight modules in nanotechnology instrumentation will be developed by a team of community college educators in July 09 at the University of Minnesota National Center for Nanotechnology Instrumentation. The first workshops in nanoscience for secondary teachers will be offered in Summer 2009. Partners are offering a variety of experiences in 2009 including student and educator workshops, informal science experiences such as NanoDays, a
nanoscience roadshow, numerous presentations to secondary school educators and students, and many more activities.

**Challenges:** Any project as ambitious as Nano-Link risks overpromising on results. We have had to constantly remind ourselves that there is far more that needs to be done than we can accomplish with our available resources. This requires constant reflection among the members to ensure that we are on target and on task. Constant communication and committed leadership are essential to overcoming this challenge. Beyond that, of course, is the challenge of getting the work done - but this was by no means an unexpected challenge!

**Poster #59**  
**Category:** A2  
**Primary Project or Approach:** Enhancing student learning through use of biological technologies (Microscopy and other visualization techniques, mass spectrometry, microarrays)  
**Institution:** Plymouth State University  
**Presenter:** Christopher Chabot  
**Email:** chrisc@plymouth.edu  
**Co-Presenter:** Gene K. Wong, Quinnipiac University  
**Field of Interest within Biology:** Neuroscience

**Goals & Intended Outcome:** The goal of the BEN collaborative is to provide a searchable database for peer-reviewed teaching materials in the biological sciences. The goal of the poster presentation is to promote this database as a useful resource.

**Methods & Strategies:** The strategy that has been adopted by the creators of BEN is to place useful, peer-reviewed resources in a database that is searchable by keywords, authors, and categories. Browsing by subject, resource type, and audience level is also easy to do.

**Evaluation Methods & Results:** BEN was established in 1999 and has grown from 12 original societies to over 30 currently. There are over 13,063 reviewed resources covering 77 biological sciences topics on BEN. While there is a claim that evaluation of this resource will occur, the data are not readily available.

**Dissemination Activities & Plans to Disseminate:** BEN Scholars have been charged with promoting the utility of BEN resources through poster presentations at conferences, departmental meetings, etc. While I suspect that most of us have been motivated to do so, it is unclear how many presentations have been made and what the impact of the presentations has been.

**Impacts of Project or Anticipated Impact:** The current impact of BEN is unclear. Most professors seem to use Google to find additional teaching resources and the at-large WWW still has many more resources than are contained in BEN. However, BEN is likely to be the best place to start to look for resources because of its focus on education. Further, if K-12 and undergraduate teachers can be convinced to upload their resources (and thus grow the database significantly), the impact can greatly increase.

**Challenges:** The submission process to BEN and its participants) should be streamlined. I submitted a resource several months ago and have not received any feedback.
Abstract: The Internet provides ready access to a large volume of material that can be used for teaching purposes. Digital libraries in particular offer a vast repository of easily accessible resources for use by teachers at all audience levels. However, in searching for specific learning items, it is often difficult to separate the "wheat from the chaff" and find accurate and useful information and techniques for the classroom or laboratory. In the biological sciences, the Bioscience Education Network (BEN) portal provides easily searchable access to digital libraries maintained by more than 25 different professional organizations (including SICB). This peer-reviewed content includes images, animations, and activities that have been tested in the laboratory or classroom and been found to be effective in helping students to understand important biological principles. While over 11,000 peer-reviewed resources covering 77 biological sciences topics are available, the BEN portal allows the user to easily narrow down the content using not only the typical search attributes such as keywords or title, but also by discipline (subject), pedagogical use, resource type, audience (education levels), author, or author institution. Organization members of the BEN Collaborative also accept materials for inclusion in the digital library through a peer-review process. The BEN Collaborative was established in 1999 by the American Association for the Advancement of Science (AAAS) with 11 other professional societies and coalitions. In 2005, the BEN Collaborative was selected as the National Science Digital Library (NSDL) Pathway for Biological Sciences education. An overview of the BEN portal and its advantages in preparing course materials will be illustrated in this poster session.

Poster #60
Category: A2
Primary Project or Approach: Enhancing student learning through use of biological technologies (Microscopy and other visualization techniques, mass spectrometry, microarrays)
Institution: Queensborough Community College
Presenter: Mangala Tawde
Email: MTawde@qcc.cuny.edu
Co-Presenter: Monica Trujillo, Queensborough Community College
Field of Interest within Biology: General Biology

Goals & Intended Outcome: Meet the specific challenges urban community college students face as they begin their studies in the Biological Sciences. Outcomes: students use on-line resources to learn and review course material; students perform better academically; faculty becomes more engaged and use more on-line resources in their classes

Methods & Strategies: Development and Implementation of Biology Interactive Technology Support: (1) Outside the Classroom (2) Within the Classroom and (3) Developing Materials to Support Undergraduate Education in Biology (textbooks (virtual and hardcopy), multimedia, access to sophisticated databases)

Evaluation Methods & Results: The evaluation will examine the feasibility of introducing this innovative technology-based learning approach with community college students and the impact this program has upon student learning and attitudes. Data to assess project and student outcomes will include assessments of student content knowledge, tracking of technology use (both within and outside of class) through the Blackboard 8.0 tools, reviews of student work, expert reviews of materials, faculty and student feedback, attitudinal surveys, observations, interviews, and focus groups as needed

Dissemination Activities & Plans to Disseminate: Presentations will be given at Biology department seminars. Data will be written up as a pedagogical paper that will be submitted to a nationally circulating peer-reviewed journal. All digital products developed during the course of this project, will be submitted to the NSF - National Science Digital Library (NSDL).
**Impacts of Project or Anticipated Impact:** Our anticipated impacts are: 1) developing alternatives to traditional teaching methods that could be successful within an urban community college setting. 2) Students will demonstrate greater persistence in science courses and improved academic achievement using this approach. 3) Faculty will actively engage in developing and implementing this project in more courses.

**Challenges:** We have not started with this project so we have not encountered unexpected challenges.

**Abstract:** The proposed project will provide support to students taking biology classes at Queensborough Community College (QCC). This college is composed of a very diverse student body, including minority students, people with full-time jobs and/or family obligations. Many of them enter QCC with little or no science background, and face enormous challenges in the classroom (both lecture and laboratory). These are students who could clearly benefit from on-line support as well as improved technology in the classroom. The proposed project will address two key issues that are crucial to the success of biology students at a community college by: 1) providing on-line support (in the form of e-supported text and virtual lab activities) that will allow for flexibility in the access of course materials 2) providing supportive technology in the form of digital workstations within the laboratory sections of their courses. This will foster collaborative learning, allow for the production of student-driven study guides, increase efficiency of learning during class time, and allow access to study materials outside of the classroom.

On-line support and digital technology will be made available to students enrolled in four biology Courses- Anatomy and Physiology I and II, non-majors Biology, and Microbiology. The expected outcome for student success is a 10% reduction in non-transferable grades and a 20% reduction in withdrawal rates. The success of the program will be assessed by student feedback and comparison to historical data concerning withdrawal rates and grade distribution. Faculty and staff feedback will also be used to evaluate the project and make appropriate adjustments as needed. Both formative and summative data will be collected, and results will be shared with the QCC community as well as with other community college faculty at local and national conferences.

**Poster #61**  
**Category:** A2  
**Primary Project or Approach:** Enhancing student learning through use of biological technologies (Microscopy and other visualization techniques, mass spectrometry, microarrays)  
**Institution:** Queensborough Community College  
**Presenter:** Monica Trujillo  
**Email:** MTrujillo@qcc.cuny.edu  
**Co-Presenter:** Mangala Twade, Queensborough Community College  
**Field of Interest within Biology:** General Biology  

**Goals & Intended Outcome:** Meet the specific challenges urban community college students face as they begin their studies in the Biological Sciences. Outcomes: students use on-line resources to learn and review course material; students perform better academically; faculty becomes more engaged and use more on-line resources in their classes.

**Methods & Strategies:** Development and Implementation of Biology Interactive Technology Support: (1) Outside the Classroom (2) Within the Classroom and (3) Faculty Development to Implement these Technologies.
**Evaluation Methods & Results:** The evaluation will examine the feasibility of introducing this innovative technology-based learning approach with community college students and the impact this program has upon student learning and attitudes. Data to assess project and student outcomes will include assessments of student content knowledge, tracking of technology use (both within and outside of class) through the Blackboard 8.0 tools, reviews of student work, expert reviews of materials, faculty and student feedback, attitudinal surveys, observations, interviews, and focus groups as needed.

**Dissemination Activities & Plans to Disseminate:** Presentations will be given at Biology department seminars. Data will be written up as a pedagogical paper that will be submitted to a nationally circulating peer-reviewed journal. All digital products developed during the course of this project will be submitted to the NSF - National Science Digital Library (NSDL).

**Impacts of Project or Anticipated Impact:** Our anticipated impacts are: 1) developing alternatives to traditional teaching methods that could be successful within an urban community college setting. 2) Students will demonstrate greater persistence in science courses and improved academic achievement using this approach. 3) Faculty will actively engage in developing and implementing this project in more courses.

**Challenges:** We have not started with this project so we have not encountered unexpected challenges.

**Abstract:** The proposed project will provide support to students taking biology classes at Queensborough Community College (QCC). This college is composed of a very diverse student body, including minority students, people with full-time jobs and/or family obligations. Many have little or no science background, and face enormous challenges in the classroom (both lecture and laboratory). These are students who could clearly benefit from on-line support as well as improved technology in the classroom. This project addresses issues crucial to the success of biology students at a community college by providing: 1) on-line support (in the form of e-supported text and virtual lab activities) that will allow for flexibility in the access of course materials 2) supportive technology in the form of digital workstations within the laboratory. This will foster collaborative learning, allow for the production of student-driven study guides, increase efficiency of learning during class time, and allow access to study materials outside of the classroom.

**Poster #62**
**Category:** A2

**Primary Project or Approach:** Enhancing student learning through use of biological technologies (Microscopy and other visualization techniques, mass spectrometry, microarrays)

**Institution:** Springfield Technical Community College

**Presenter:** Dawn Tamarkin

**Email:** Tamarkin@STCC.edu

**Field of Interest within Biology:** General Biology

**Goals & Intended Outcome:** To increase retention of students in biology and STEM through inclusive strategies for learning. To create opportunities for all students, regardless of disability, socioeconomic status, or minority status, to succeed in biology.

**Methods & Strategies:** Universal Design for Learning (UDL) models of the cell enable tactile and interactive modeling of specific cells viewed under the microscope, ensuring cell recognition in the scope. Teaching introductory biology in a learning community (LC) run using UDL and where STEM learning & studying strategies are also taught.
Evaluation Methods & Results: Evaluation of the LC model is through multiple means. The performance of students with and without disabilities in either control (non-LC) or experimental (LC) STEM classes is being compared. Comparison of course grades, retention and pre- and post- tests (content knowledge, attitude, and learning skills). Initial analysis reveals a 31.7% increase in success for all students in the experimental group over the control group; no students failed or withdrew from the LC. Evaluation of the UDL cell models was carried out through classroom testing at high schools and colleges; results unclear due to lack of full participation.

Dissemination Activities & Plans to Disseminate: Initial data has been presented at meetings (ISETL and MA CCs) and at STCC. Future dissemination includes distribution of two guidebooks: 1) STEM studying and learning methods; and 2) how to set up an LC like those in this project. Also, a summer meeting for UDL cell model training and distribution will run.

Impacts of Project or Anticipated Impact: The major impact so far was how successful the LC students were; they outperformed any other biology class success at the college. This is particularly promising because half the LC students were students with disabilities. Additional impacts are that the college has undergone a cultural change to accept LCs as a valid instructional method, and the LC faculty were highly motivated to try this LC model again. An anticipated impact of the UDL cell models is a change in the way that cells are taught in labs to a more applied and interactive method.

Challenges: The most surprising unexpected challenge was that teachers who had agreed to use UDL cell models in their classrooms and were shown how to use them still did not incorporate them. Some instructors were even unclear about what a cell lab would be or whether they would use microscopes in lab. The way to deal with this is to develop a thorough guidebook for UDL model use that includes lesson plans. An unexpected challenge on the LC project was the difficulty in getting enrollment the first time; the way this was resolved was by presenting the positive results of the first LC to the college-- enrollment has been easy the second time.

Abstract: We are challenged to provide comprehensive and rigorous introductory biology classes while retaining diverse students and enabling their achievement. When we cannot meet this challenge, students not only leave biology courses, but may also leave STEM programs of study. Introductory biology can be especially daunting to students with disabilities—merely accommodating their specific needs does not necessarily lead to their success. We need to use approaches toward biology education that include more learners to retain more students in STEM. Two approaches funded by NSF awards (DUE #0618182 & HRD #0726473) have produced successes in learning for all students in a non-majors’ introductory biology course: universal design for learning (UDL) and learning communities (LCs). These approaches and their resultant successes are described here.

Poster #63
Category: A2
Primary Project or Approach: Enhancing student learning through use of biological technologies (Microscopy and other visualization techniques, mass spectrometry, microarrays)
Institution: University of Massachusetts
Presenter: Elizabeth Connor
Email: econnor@bio.umass.edu
Co-Presenter: Katherine Dorfman, University of Massachusetts
Field of Interest within Biology: General Biology

Goals & Intended Outcome: We designed team-taught interdisciplinary courses with a bioimaging or genomics focus to provide students with the research skills and techniques most often obtained from in-
dependent research experiences. Our goals are for students to increase their learning, to develop skills of a scientist, and to develop positive attitudes about practice of science.

**Methods & Strategies:** We designed open-ended laboratory experiences using equipment and techniques common in today’s research laboratories. These guided experiences provide students opportunities to design and conduct their own experiments, frequently integrate biological principles with those of physics and chemistry, and emphasize quantitation.

**Evaluation Methods & Results:** The courses were evaluated with a combination of tools including midsemester assessment forms, Pre/Post Classroom Undergraduate Research Experience (CURE) surveys, student teaching evaluations (SRTI), and instructor and teaching assistant interviews. Student and instructor enthusiasm for the course was generally high and student gains were observed in laboratory skills, attitudes toward science, and an interest in pursing science as a career.

**Dissemination Activities & Plans to Disseminate:** Course projects have been presented at several conferences: Redesign Alliance National Conference and Disciplinary Institutes (2008, 2009), UMASS Undergraduate Life Science Research Symposium (2008, 2009), and Best Practices in Science Education Conference (2008). We plan to publish our course projects in CBE’s Life Sciences Education.

**Impacts of Project or Anticipated Impact:** Our project has increased student enthusiasm not only for our courses, but also for research and research-related activities. It has initiated a sea change in the culture of science among undergraduates on our campus. It has also enhanced awareness of how we train life scientists. We anticipate increases in inter-departmental collaboration in designing life science curricula, as well as in student success in pursuing careers in the life sciences.

**Challenges:** The offering of interdisciplinary courses is a challenge since teaching assignments cross departmental boundaries. We have found that leadership at the college level is important in maintaining these teaching commitments. We were also surprised to find interdisciplinary teaching at the introductory level to be challenging; students have preconceived notions of what biology and chemistry are and were puzzled at the appearance of chemical principles in an introductory biology course. We are working a presentation techniques to address this issue.

**Poster #64**

**Category:** A3

**Primary Project or Approach:** Biology as related to world problems (climate issues, economics, health, service learning, community outreach)

**Institution:** Brandeis University

**Presenter:** Dan Perlman

**Email:** perlman@brandeis.edu

**Field of Interest within Biology:** Ecology and Environmental Biology

**Goals & Intended Outcome:** Project 1, Brandeis Environmental Field Semester: Help students learn about conservation and environmental history from 4-course integrated program. Project 2, EcoLibrary: A source for free downloadable materials to help students learn about ecology, environmental studies, and conservation biology.

**Methods & Strategies:** 1. Field Semester: This interdisciplinary full-semester program is team-taught with a focus on original research and writing. 2. EcoLibrary: This Web site makes high quality images available (and soon, other materials) with high quality supporting information.
Evaluation Methods & Results: 1. Field Semester: We gave pre- and post-semester evaluations of complex conservation problems, supplemented by various questionnaires. We also employed a variety of different assessments during the semester, ranging from field tests and quizzes to natural history essays and major research projects. 2. EcoLibrary: I look forward to working with professor and teacher volunteers to assess the value of these materials, which have not yet received formal evaluation in classrooms.

Dissemination Activities & Plans to Disseminate: 1. Field Semester: My colleagues and I have begun discussing the program at professional meetings, and plan to write about our methodology for journals. 2. EcoLibrary: I have demonstrated the Web site at various professional meetings and plan to approach journals for formal reviews.

Impacts of Project or Anticipated Impact: 1. Field Semester: The program clearly has profound impacts on our students who write comments such as, "Learning inside and outside the classroom, in a setting where all of our courses built upon each other, was the perfect way to really solidify new knowledge, and to change my way of thinking." and "Because of this approach to learning, I have gained more knowledge--and been more fully engaged--this semester than in all my previous semesters combined." 2. EcoLibrary: I expect that the site will help students engage with the world around them and actively learn from the multimedia materials we provide.

Challenges: 1. Field Semester: While the program has had tremendous impact on the lives of our students, it has sometimes been difficult to help administrators see the value of running labor-intensive programs for such small groups (~12 students/semester). However, my university is now developing a large number of small, intensive, summer- or semester-long programs, much like the Field Semester. 2. EcoLibrary: Clearly the next step to take in the development of EcoLibrary is to include materials from other scientists. I am still developing a method for doing so while keeping the quality of the materials uniformly high.

Poster #65
Category: A3
Primary Project or Approach: Biology as related to world problems (climate issues, economics, health, service learning, community outreach)
Institution: Duquesne University
Presenter: Nancy Trun
Email: trun@duq.edu
Co-Presenter: Lisa Ludvico, Duquesne University
Becky Morrow, Duquesne University
Field of Interest within Biology: General Biology

Goals & Intended Outcome: Our hypothesis is that because, in an ABSL course, students are involved in publishable novel research that can benefit their community, they will learn the scientific concepts needed for hypothesis-driven research more thoroughly and retain them longer.

Methods & Strategies: We are developing a novel strategy for teaching undergraduate science courses that we call application-based service learning (ABSL). It is a combination of the service learning and novel student research on a community based problem.

Evaluation Methods & Results: We are using three types of pre and post examinations. One on service learning (developed at UC Berkeley), one on student attitudes and one on scientific content.

Dissemination Activities & Plans to Disseminate: We are adding new investigators and universities across the country who are interesting in ABSL. We want to develop a network of courses, each working
on a part of the novel research on our community problem. We are currently developing a website with information on ABSL.

**Impacts of Project or Anticipated Impact:** We anecdotally have seen an increase in students conducting undergraduate research and a greater interest in experiments. We are currently quantifying these results. We have seen an impact on our community partner and the amount of work they have accomplished with our students volunteering. We are currently writing the first journal article to be submitted to a peer-reviewed scientific journal and using the students’ data.

**Challenges:** The biggest challenge is to determine the most appropriate courses for ABSL and the appropriate service learning projects.

**Abstract:** Application-based service learning in a Biology majors course: Combining service learning and novel research on a community based problem

We are developing a novel strategy for teaching undergraduate science courses that we call application-based service learning (ABSL). It is a combination of the service learning and novel student research on a community based problem. Through service learning, students learn about a community problem. In laboratory or lecture classes, students conduct novel research on some aspect of the community problem. ABSL has two major strengths: 1) students are more engaged in learning because they are addressing a real-life, readily assessable problem that they can help fix; and 2) students conduct research on a problem that is little studied because the problems are usually very applied and not always fundable through traditional mechanisms. Our hypothesis is that because students are involved in publishable novel research that can benefit their community, they will learn the scientific concepts needed for hypothesis-driven research more thoroughly and retain them longer. Preliminary data from a majors lab class indicates much more student interest in this class as opposed to traditional lab courses, better mastery and retention of the lab techniques and a greater commitment to carefully conducting experiments.

**Poster #66**
**Category:** A3
**Primary Project or Approach:** Biology as related to world problems (climate issues, economics, health, service learning, community outreach)
**Institution:** Elon University
**Presenter:** Jeffrey Coker
**Email:** jcoker@elon.edu
**Field of Interest within Biology:** General Biology

**Goals & Intended Outcome:** Reinventing Life is a new introductory biology course for non-science majors focused on modern biological change and the future of life. Humans are rapidly changing life on every level, and these changes underlie most concepts necessary for scientific literacy and civic engagement related to biology.

**Methods & Strategies:** Reinventing Life uses modern biological change as the central theme, linking fundamental concepts with cutting-edge science related to environmental change, stem cell research, genetic engineering, synthetic biology and other modern paradigms. The course includes modern examples of biological change, discussions on bioethics, a biological design project, and an emphasis on inquiry and active learning. The associated lab involves four multi-week experiments that are designed, implemented, analyzed, and presented by the students.
**Evaluation Methods & Results:** The Reinventing Life course has been thoroughly evaluated on the campus of Elon University. We have assessed student learning, impressions about science, attitudes toward biology-related issues, scientific process skills, etc. Overall, the course has been extremely effective at Elon. Ideally, the course concept would be evaluated at other institutions, as well.

**Dissemination Activities & Plans to Disseminate:** An article describing the Reinventing Life course was recently published in American Biology Teacher (2009, Vol. 71, pp. 281-284). Other institutions have adopted parts of Reinventing Life as a result of this publication and other conference presentations. Discussions are currently underway with publishers involving a book for classroom use by other institutions.

**Impacts of Project or Anticipated Impact:** Reinventing Life has become a new course at Elon University (Bio 103) that is offered as an alternative to the traditional course for the general student population. It has become very popular at Elon, and other campuses are beginning to adopt the course (or parts of it).

**Challenges:** At most institutions, the major challenges in changing Introductory Biology courses involve faculty buy-in and institutional support. Many would like to teach as they were taught, regardless of changes that have taken place in biology, student populations, and the larger world. At Elon University, Reinventing Life was funded and supported by the Center for the Advancement of Teaching and Learning and evolved through several stages before finally becoming its own course.

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**Poster #67**  
**Category: A3**  
**Primary Project or Approach:** Biology as related to world problems (climate issues, economics, health, service learning, community outreach)  
**Institution:** Furman University  
**Presenter:** Min-Ken Liao  
**Email:** min-ken.liao@furman.edu  
**Field of Interest within Biology:** Microbiology, Virology  

**Goals & Intended Outcome:** We developed a course on Disease and Culture in which students learn about infectious diseases through discussions and writing. The objectives are (1) to use the study of diseases to arouse students’ curiosity and interest in the scientific bases and historical and societal impacts of diseases, (2) to enhance students’ understanding and appreciation of the research process, and (3) to use established scientific knowledge as background to critically and ethically evaluate preconceptions and assumptions.

**Methods & Strategies:** We had mini-lectures, laboratory exercises and current issues to enhance students’ understanding of six diseases and watched the Rx for Survival series (PBS) to expose students to the global aspect of different diseases. We used writing to help students attain a higher order of learning. Each pair of students selected a disease as the focus of their individual writing and pair presentation.

**Evaluation Methods & Results:** Two assessment methods were used: Survey Monkey and Focus Group Interview. Students’ responses are overwhelmingly positive.

**Dissemination Activities & Plans to Disseminate:** This project has been presented at the General Meeting of American Society for Microbiology this May.
Impacts of Project or Anticipated Impact: Students’ responses are overwhelmingly positive. In addition, we just received an invitation to write a chapter about this project for a book on team-teaching.

Challenges: Most challenges are administrative. There are nothing we could and can do to change that.

Abstract: Learning Infectious Diseases through Writing: First Year Seminar on Disease and Culture

To introduce students to the intellectual life of the liberal arts college, we (a microbiologist and a philosopher) developed a writing-intensive First Year Seminar (FYW) course on Disease and Culture in which students learn about infectious diseases through discussions and writing. The objectives of this course are (1) to use the study of diseases to arouse students’ curiosity and interest in the scientific bases and historical and societal impacts of diseases, (2) to enhance students’ understanding and appreciation of the research process, and (3) to use established scientific knowledge as background to critically and ethically evaluate preconceptions and assumptions. Furthermore we used writing to help students attain a higher order of learning. We selected cholera, tuberculosis, plague, AIDS, syphilis, malaria for their historical, social/cultural, and biological significances. Each disease was associated with mini-lectures, laboratory exercises and current issues to enhance students’ understanding of the disease. We used the Rx for Survival series (PBS) to expose students to the global aspect of different diseases. The Ghost Map by Steven Johnson was used to teach cholera and to model writing. Two weeks into the semester, each pair of students selected a disease as the focus of their writing project. As a pair they investigated the history, social/cultural, and biological aspects of the chosen disease and individually wrote a five-page paper on each aspect in two to three weeks interval. All pairs were encouraged to review each other’s draft before and after the submission of each writing assignment. Students combined all three parts into a 12-15-page final draft, and we held a 20-minute writing conference with each student before they turned in their final draft. This semester-long writing project not only enhanced their writing skills, it also deepened their understanding of the chosen disease. Two assessment methods were used: Survey Monkey and Focus Group Interview. Students’ responses are overwhelmingly positive. The preparation of this course and the dissemination of this work are funded by Associated Colleges of the South.
Dissemination Activities & Plans to Disseminate: As we have just initiated this effort, we have not performed any dissemination.

Impacts of Project or Anticipated Impact: We anticipate that non-science majors will opt to take these types of courses over those courses design for majors in order to fulfill their general education science requirement.

Challenges: Its too early to tell.

Abstract: As society becomes more dependent upon technology and science, the need for college to include science, and particularly biology, in their general education programs becomes increasingly important. Under the auspices of the Mellon Foundation, Hunter College has been examining its general education science requirement. Most non-science major students often have negative attitudes toward science, which translates to poor performance and learning outcomes in basic introductory science courses. While hands-on learning has been shown to engage these students, most college science classes are lecture and content oriented. Typically, such courses overlook critical thinking skills and focus on teaching detailed, discrete facts. Yet, most students learn best with concrete, contextual experiences where they are intellectually engaged in problem solving. Therefore, we are developing hands-on science courses to teach critical thinking skills in the context of biology to non-science majors.

Two courses will be offered in the upcoming year. A course on forensic science stresses cell biology. Lectures are paired with labs exploring sample identification, acquisition and analysis. The course culminates with a mock crime scene, where students collect and analyze data, and then present their findings and conclusions at a mock trial as forensic science experts for the prosecution.

The second course, on human biology, covers contemporary issues such as cancer, infectious diseases and reproductive biology. The course stresses anatomy and physiology focusing on disease processes, gender and population differences, and taboos that significantly influence research and open discussion of health issues. Lectures are paired with labs dealing with exploring human physiological processes and aspects of disease diagnosis. The course culminates with student research and presentation of a major current concern in human biology. Here we present the curricula developed for these courses as well as some of the preliminary assessment for the forensic science course.

Poster #69
Category: A3
Primary Project or Approach: Biology as related to world problems (climate issues, economics, health, service learning, community outreach)
Institution: Kean University
Presenter: Rongsun Pu
Email: rongsun.pu@gmail.com
Co-Presenter: Hank Kaplowitz, Kean University
Jeffrey Toney, Kean University
Field of Interest within Biology: Science and Human rights

Goals & Intended Outcome: The project aims to integrate the application of scientific concepts and methods that are related to human rights issues into the undergraduate biology curriculum.

Methods & Strategies: We propose to use case studies in which scientists have used their specialized knowledge and expertise to benefit human rights causes both in the US and globally.
**Evaluation Methods & Results:** The evaluation will be composed of before- and after-course surveys, classroom discussions, individual presentations and term papers to assess students' understanding of facts, different points of view, and their comprehension of the relevance of a scientific training to advancing human rights.

**Dissemination Activities & Plans to Disseminate:** In addition to enhancing and transforming undergraduate biology education, this project also aims to contribute to AAAS's Science and Human Rights Coalition program. A proposal for a feature article has been submitted to American Scientist, the journal of Sigma Xi. Currently we are also looking into external funding sources.

**Impacts of Project or Anticipated Impact:** We expect this project to deeply interest and engage undergraduate biology students and to have a transforming effect on their perspectives of what they can contribute to the pressing issue of human rights violations both in the US and abroad.

**Challenges:** This project has not been implemented in the classroom.

**Abstract:** Science and Scientists Advancing Human Rights

As "one of the greatest spiritual adventures man has yet known" (Karl Popper), science and its advancement have contributed enormously to the well-being of the society since the dawn of civilization. In December 1948, the Universal Declaration of Human Rights was adopted. In January 2009, AAAS launched the Science and Human Rights Coalition. The goal of the Coalition is to foster collaborative work between scientists and human rights practitioners to realize human rights globally. Locally, the importance of human rights education was recognized at Kean University through the development of the Human Rights Institute. We propose a novel pedagogical tool to engage biology undergraduate students. As scientists-in-training in a world where human rights violations continue to occur, today's undergraduate biology students have an opportunity to contribute to the alleviation of human suffering and to extend human rights to those in need as they learn. We present case studies in which scientists have used their specialized knowledge and expertise to benefit human rights causes both in the US and globally. Scientific capability and social responsiveness are valuable components of a quality undergraduate biology education. We discuss plans to integrate the application of scientific concepts and methods that are related to human rights issues into the undergraduate biology curriculum.

**Poster #70**

**Category:** A3

**Primary Project or Approach:** Biology as related to world problems (climate issues, economics, health, service learning, community outreach)

**Institution:** La Roche College

**Presenter:** Gail Rowe

**Email:** gail.rowe@laroche.edu

**Field of Interest within Biology:** Microbiology, Virology

**Goals & Intended Outcome:** My goal to offer real biology research experience at a small undergraduate, non-research college where resources & faculty responsibilities are for classroom teaching, not basic research. Intended outcomes are getting more students involved in research & enhancing science skills & sense of social responsibility.

**Methods & Strategies:** I developed a 2-semester course as a model of application-based service learning (novel lab research w/ service to solve a community problem.) BioSOLVE I teaches basic theory, specific lab skills, the nature of the problem & collaboration. BioSOLVE II focuses on lab research. Both require service & outreach.
**Evaluation Methods & Results:** To assess social responsibility, a Civic Responsibility Survey (Diaz, Furco, Yamada, 1999) was given pre- & post- BioSOLVE I & post-BioSOLVE II. A course evaluation given post-BioSOLVE II assessed students’ view of the courses, research, service, & what they had learned. Analytical, presentation & lab skills were assessed by graded lab work, notebooks, scientific writing & presentations. To assess content retention, students were retested on BioSOLVE I exams after BioSOLVE II. Interest in research was shown by # of students taking BioSOLVE II, # that performed extra research & subsequent internship, Honors & Ph.D. work.

**Dissemination Activities & Plans to Disseminate:** Dissemination includes presenting at AAAS, submitting an abstract on BioSOLVE for a 2009 branch meeting & 2010 general meeting of the American Society for Microbiology (ASM), co-presenting ABSL w/ N. Trun at an education symposium at ASM, submitting ABSL work for publication in STEM journals, & more collaborators.

**Impacts of Project or Anticipated Impact:** BioSOLVE increased student interest, involvement & skills in biology laboratory research as well as understanding of & commitment to community service. Bio- SOLVE work helped place students in research & service positions (internship, Ph.D. program, employment). Student success helped gain support for biology re- search from other biology faculty & administration at the college & is used in college recruitment efforts. Outreach activities helped educate our campus community & created interest in related community service. Future impacts may include publications, improved reputation of the college, and expansion of ABSL.

**Challenges:** The big challenge has been low student enrollment in BioSOLVE; related to uninformed students & ambivalent science faculty. Plans are to more effectively remind faculty & other academic advisors of the BioSOLVE option & to keep faculty updated on BioSOLVE’s successes so more advisors will value the initiative & encourage their students to enroll. Biology & Chemistry Seminar students who saw BioSOLVE student research presentations were greatly impressed and would like to have participated, but they were graduating. We need a venue for Bio-SOLVE students to present to less advanced students who could then enroll later.
Abstract: Cellular and molecular biology core course redesign using a uniting theme of cancer. Cellular and molecular biology is a core curriculum course for biology majors at Roosevelt University serving as a foundation for the upper-level majors courses. Previously this course was taught as a traditional, content-driven science course. This course has been redesigned during the last several years to connect the concepts of cellular and molecular biology to complex diseases using the uniting theme of cancer. General cellular and molecular biology concepts are discussed during standard class meetings while connections to cancer pathology are made during weekly discussion sessions. Students have weekly assignments integrating class discussions on cell and molecular processes with the development of cancer. The course also contains a civic engagement project component. Assessment is completed using a series of class assignments and exams as well as pre- and post-SENCER-SALG instruments. Comparison to the previous content-driven course offering, students who have taken this course with the uniting theme of cancer report an increase in understanding in course content as well as civic engagement as a result of the course pedagogy. Large gains were reported in likelihood of future advocacy and volunteerism in scientific related activities.
Field of Interest within Biology: Multiple disciplines, multiple interests

Goals & Intended Outcome: Science Education for New Civic Engagements and Responsibilities (SENCER) was initiated in 2001 under the National Science Foundation’s CCLI national dissemination track. Since then, SENCER has established and supported an ever-growing community of faculty, students, academic leaders, and others to improve undergraduate STEM (science, technology, engineering and mathematics) education by connecting learning to critical civic questions. SENCER is the signature program of the National Center for Science and Civic Engagement, which was established in affiliation with Harrisburg University of Science and Technology.

Methods & Strategies: We support a community of practice by offering faculty development programs through regional symposia and our annual Summer Institutes, and supplement those interactions with a collection of resources, including field-tested featured and emerging course models, backgrounder papers, and a monthly e-newsletter. We also encourage and participate in the development of assessment strategies and tools that help educators better evaluate and promote student learning and engagement.

Evaluation Methods & Results: Key findings from the extensive, independent multi-year evaluation of the SENCER project, conducted by Elaine Seymour, Tim Weston and Heather Thiry, confirm this. Their report provides evidence that "SENCER's goal of encouraging faculty to teach courses with civic content and innovative pedagogy is a reality." The researchers also confirm that the SENCER reforms are durable, noting that they found that "92% of instructors believed that their courses would be continued in the future, and 80% considered their course part of the permanent curriculum at their institution." The data provided by 10,000 students in 345 SENCER courses who completed the SENCER-SALG have been analyzed.

Dissemination Activities & Plans to Disseminate: Since its inception, SENCER has established formal projects designed to develop and implement SENCER courses with teams that have included more than 1,100 faculty, administrators, and students from over 300 high schools, colleges, and universities located in 166 US congressional districts and 13 foreign nations. Since its inception, the SENCER ideals, programs, and materials have been shared with thousands more STEM faculty and academic leaders at symposia, poster sessions, disciplinary society meetings and other workshop venues in the US and countries around the world.

Impacts of Project or Anticipated Impact: In addition to the important outcome of helping faculty make "meaningful changes to their instruction," the data tell who gains and what they gain from their study in SENCER courses. There is also evidence that the SENCER approach strengthens learning for women, minorities, and students who major in non-STEM fields, as well as for those who have chosen to major in a STEM field. More detailed information, including the full text of the 2006 final report, can be found in the Assessment section of the SENCER website (http://sencer.net).

Challenges: Cross-cutting issues that animate dimensions of SENCER’s current and future work include: (1) increasing the level of science and mathematics learning achieved in SENCER courses and connecting this knowledge to workforce challenges, (2) using the SENCER approach to attract more students to pre-service teacher education (especially at the elementary school level) and exploring the feasibility of developing primary and secondary school SENCER course and curricular projects in college-level courses, (3) extending the SENCER approach to the education of STEM majors, and (4) using the diverse SENCER community to strengthen connections between community and four year colleges. These matters are critical to our nation’s economic competitiveness and civic welfare.
Poster #73  
Category: A3  
Primary Project or Approach: Biology as related to world problems (climate issues, economics, health, service learning, community outreach)  
Institution: Trinity University  
Presenter: Liliana Losada  
Email: losadal@trinitydc.edu  
Co-Presenter: Iliana Restrepo, Trinity University  
Field of Interest within Biology: Microbiology, Virology

Goals & Intended Outcome: The main goal of this project is to make biology and science in general more inclusive and accessible to underrepresented students. The project will allow students to take part in innovative research throughout their curriculum and develop a portfolio of work related to a specific topic with a community outreach or local impact.

Methods & Strategies: Students are placed in Learning communities which are assigned a research topic that they will explore throughout their curriculum at Trinity. In order to ensure that students also gain significant ownership of the project, topics are selected to have a community outreach or local impact component.

Evaluation Methods & Results: The LC-advisor will establish a focal theme for that community, and those students will develop a portfolio of work, including (but not limited to) research projects in organic chemistry, microbiology and senior seminar, that would be related to that LC-focal theme. By the end of four or five years, students could accumulate knowledge, techniques, and research about that theme from diverse courses. Assessment of student progress will be conducted both through classroom activities and reports, as well as by individual meetings with the LC advisor who will use specific rubrics to detail the progress of scientific method and thinking.

Dissemination Activities & Plans to Disseminate: By the end of their Bachelor's students are expected to present their work to the Trinity community orally. In addition, depending on the nature of the topic they have investigated and the community they have worked with, students will prepare a report for that community. The results from the implementation of this project will be presented for publication.

Impacts of Project or Anticipated Impact: So far, two classes have been assigned to Learning communities and we have seen an increase in retention at the college level of greater than 6% and specifically in biology and sciences the retention has increased by over 30%. We attribute this increase to the greater amount of support provided for each student, but also to the establishment of learning communities which have allowed students to feel like they belong at Trinity. These students will be entering chemistry and biology courses in the fall that will demand individual research projects and we expect the students will outperform previous iterations of these projects.

Challenges: Due to our success in retaining students and now attracting more students, we are facing administrative issues such as classroom and laboratory space shortages, not enough equipment for all students, and staffing problems.
Poster #74  
**Category:** A3  
**Primary Project or Approach:** Biology as related to world problems (climate issues, economics, health, service learning, community outreach)  
**Institution:** University of Alaska Fairbanks  
**Presenter:** Lawrence Duffy  
**Email:** ffldk@uaf.edu  
**Field of Interest within Biology:** Interdisciplinary Biology  

**Goals & Intended Outcome:** We need to engage students by including the current issues and concerns of our students as well as recognizing the place-based context in which they learn. Including culture, policy and traditional knowledge when it intersects with a biological or chemical principle and a challenging real world issue adds concreteness to the scientific process.

**Methods & Strategies:** Science Education for New Civic Engagement and Responsibilities is a national dissemination project for courses in science, technology, engineering and mathematics. SENCER courses connect science and civic engagement by teaching through complex, capacious, current and unresolved public issues to the underlying scientific principles.

**Evaluation Methods & Results:** The more that our students are exposed to culturally responsive interdisciplinary science courses that encompass biocomplexity, the more prepared they will act as agents of long term stewardship through periods of rapid change and ecological challenge. It is therefore critical that issues such as sustainability, environmental health and justice, food security, and precaution be integrated into science teaching. In studying public issues of the north, students and faculty can use examples from traditional knowledge to illustrate the use of science principles. Evaluation was carried out using the Student Assessment of Learning Games (NSF SALG) on-line site.

**Dissemination Activities & Plans to Disseminate:** Abstract and publication of results in science journals.

**Impacts of Project or Anticipated Impact:** As part of the IPY UARCTIC effort, examples from climate change, nutrition, nuclear science and chemical ecology were developed to illustrate this integration. The courses adapted and delivered at an arctic university will illustrate the benefits of integrating social and cultural topics with science. Student responses showed an increase in interest in science. The Adapt and Adopt process is synergistic and should be goal oriented. This approach is especially relevant to minority and indigenous students who are engaged in the issues of their local community.

**Challenges:** Students tend to take only required courses in their major. Also, traditional department chairs do not appreciate the value of interdisciplinary courses.

**Abstract:** Engaging Students in Science by Including Traditional and Local Knowledge: The SENCER Approach in the Arctic

Problem Statement: In our undergraduate biology and chemistry courses, we need to engage students by including the current issues and concerns of our students as well as recognizing the place-based context (i.e. arctic) in which they learn. Including culture, policy and traditional knowledge when it intersects with a biological or chemical principle and a challenging real world issue adds concreteness to the scientific process.

Approach: Science Education for New Civic Engagement and Responsibilities is a national dissemination project for courses in science, technology, engineering and mathematics. SENCER courses connect science and civic engagement by teaching through complex, capacious, current and unresolved
public issues to the underlying scientific principles. The more that our students are exposed to culturally responsive interdisciplinary science courses that encompass biocomplexity, the more prepared they will act as agents of long term stewardship through periods of rapid change and ecological challenge. It is therefore critical that issues such as sustainability, environmental health and justice, food security, and precaution be integrated into science teaching. In studying public issues of the north, students and faculty can use examples from traditional knowledge to illustrate the use of science principles.

Results: As part of the IPY UARCTIC effort, examples from climate change, nutrition, nuclear science and chemical ecology were developed to illustrate this integration. The courses adapted and delivered at an arctic university will illustrate the benefits of integrating social and cultural topics with science. Student responses showed an increase in interest in science.

Conclusion: The Adapt and Adopt process is synergistic and should be goal oriented. This approach is especially relevant to minority and indigenous students who are engaged in the issues of their local community. The SENCER approach to arctic science creates a legacy of new, engaging courses in the north. (Funded in part by NSF, DUE 0632397)

Poster #75
Category: A3
Primary Project or Approach: Biology as related to world problems (climate issues, economics, health, service learning, community outreach)
Institution: University of Kansas
Presenter: Raymond Pierotti
Email: pierotti@ku.edu
Co-Presenter: Octaviana Trujillo, Northern Arizona University
Douglas Causey, University of Alaska, Anchorage
Anne Calhoun, University of New Mexico
Field of Interest within Biology: Ecology and Environmental Biology

Goals & Intended Outcome: Native Americans remain the most underrepresented group among undergraduate science majors, graduate students, and science faculty. We directly tackled this situation by empowering and inspiring Native American and Alaska Native students through development of a cohesive Native American Science curriculum.

Methods & Strategies: Courses are enhanced by development of web-based interactive applications, which helps to compensate for the lack of published textbooks in the field, as well as by distance-delivery technology that allows faculty to provide lectures and discussions for courses offered at other institutions.

Evaluation Methods & Results: Our assessment of student progress and evaluation of meeting project objectives addresses both course content and cultural context and sensitivity. Our experience shows that an approach to STEM courses derived from an Indigenous perspective provides a pedagogical framework that is more inviting and intuitive for many students, not only Native American students but also other minority groups, women, and non-traditional students. These results should improve STEM education in general, while providing both a model for and inspiration to students who might otherwise avoid STEM courses and majors.

Dissemination Activities & Plans to Disseminate: We have completed development of five courses: 1) Native and Western Views of Nature, 2) Natural Resource Management from an Indigenous
Poster #76
Category: A4
Primary Project or Approach: Student Research introduced as an Integral Part of Traditional Courses and Introduction of Technologies New to Biology
Institution: Adelphi University
Presenter: Lawrence Hobbie
Email: hobbie@adelphi.edu
Field of Interest within Biology: Genetics

Goals & Intended Outcome: The goals are to increase student understanding of genetic concept and mastery of techniques in genetics, together with long-term retention.

Methods & Strategies: In genetics lab, students begin with guided experiments and progress to independent research projects. In the genetics classroom, small group work focused on understanding concepts and solving problems has largely replaced lectures.

Evaluation Methods & Results: Evaluation methods have included tests of student knowledge and understanding, and surveys of student satisfaction and self-evaluation. Results indicate high levels of student satisfaction with these approaches but surveys to measure long-term retention have been unsuccessful due to low response rates.

Dissemination Activities & Plans to Disseminate: Oral presentations on the genetics project lab approach have been made to the department and to science faculty at the university. A poster presentation on the genetics project lab approach was made at the International Conference on Arabidopsis Research in 2008.

Impacts of Project or Anticipated Impact: Local impacts include the adoption of various features of the inquiry-based approach by colleagues and the promotion of student interest in research. Desired impacts include more widespread adoption of such approaches.

Challenges: The greatest challenge has been in developing and following through with adequate assessment approaches. I am still working on addressing this challenge.

Abstract: Inquiry-Based Approaches to Teaching Genetics

One semester undergraduate genetics lecture and lab courses that use inquiry-based and student-
centered approaches have been successfully implemented at Adelphi University. In the genetics project lab, undergraduate students learn key concepts and techniques in classical and molecular genetics and develop their research skills through projects using the plant Arabidopsis thaliana. Students begin with guided labs that introduce the analysis of inheritance patterns, characterization of phenotype using a simple physiological assay, and the fundamentals of PCR-based mapping, all using a collection of auxin-related mutants isolated in the author’s research. Students then design and carry out their own phenotypic analysis experiment and pursue rough mapping of their assigned mutants independently. At the end of the course they present their results in a poster session. This inquiry-based course helps foster students’ development as scientists and supports a strong culture of student-centered research at Adelphi.

In the genetics lecture course, recently-implemented approaches that include extensive small group work during class and occasional skits have replaced lectures. Student responses to both courses have been positive.

**Poster #77**
**Category:** A4
**Primary Project or Approach:** Student Research introduced as an Integral Part of Traditional Courses and Introduction of Technologies New to Biology
**Institution:** Alabama A&M University
**Presenter:** Florence Okafor
**Email:** florence.okafor@aamu.edu
**Co-Presenter:** Jeanette Jones - Alabama A&M University
**Field of Interest within Biology:** Microbiology, Virology

**Goals & Intended Outcome:** Establish a supplemental instruction program in the sciences and Mathematics to enhance student retention and persistence in the Biological sciences. Provide counseling which includes experiential learning & internship opportunities to enhance their entrance into graduate, professional and workforce environments.

**Methods & Strategies:** Provide scholarships for qualified freshman students in biology and chemistry. The Biology Department at Alabama A&M University (AAMU) focuses on students’ active engagement in the learning process, on the curriculum modifications, faculty development and facility acquisition.

**Evaluation Methods & Results:** Formative evaluation will be used to ensure that our goals are achieved and to improve program activities, by means of identification and subsequent remediation of any problematic aspects. Each student will be evaluated to determine how well each is progressing. Some of the tools to be used will include one-on-one or small group interviews and surveys. Summative evaluation will be used both midway and at the end of the program activities. It will involve determination of attitudes and student perceptions using a brief questionnaire to determine their experiences with mentoring, seeking help from professors, supplemental instruction, research experiences, internships and their overall perceptions of the social climate in AAMU STEM areas.

**Dissemination Activities & Plans to Disseminate:** The successes and possible pit-falls of the program will be disseminated to the academic community through conference presentations, journal publications and the AAMU website.

**Impacts of Project or Anticipated Impact:** Our anticipated impact include: Advance the knowledge, training, and experiences of AAMU Biology students by providing an enhanced level of academic training and opportunities for under-represented minority. We also hope to impact the university’s re-
search resources, infrastructure, and capacity by strengthening the undergraduate STEM programs and produce a higher number of students who are well-trained and who will subsequently enter graduate school or the workforce.

**Challenges:** Challenges include: Buy-in to the project by all faculty, recruiting students and lack of funds and adequate infrastructure. How do we adequately approach the question of program and course assessments? How do we track our graduates on a long term basis?

**Abstract:** Alabama A&M University is an 1890 Land Grant University located in historic Huntsville, Alabama. The strategic plan of AAMU entitled “FOCUS 2015: Blueprints to Excellence”, quality enhancement plan clearly reflects its commitment to enhancing the learning environment. The goals of focus 2015 include: (1) expanding extension/outreach/public service, and (2) creating and implementing a national model for student retention/graduation with emphasis on students with limited educational access. The university is organized into six undergraduate schools including the school of Arts & Science which houses the Biology Department. Diverse Issues in Higher Education (June 12, 2008 edition), reported that AAMU is ranked 13th in awarding biological and biomedical sciences degree to African American students. The Biology Department at Alabama A&M University (AAMU) focuses on students’ active engagement in the learning process, on the curriculum, faculty development and facility acquisition. We place emphasis on the students’ class room learning, experiential learning through internships (career and academic); we also emphasize student support services such as mentoring by faculty and peers, supplemental instruction, increasing faculty-student interactions through curriculum modifications and research, forging articulation agreements with existing partners in the Business/Industry cluster, and expanding interdisciplinary options. The provision of scholarships to freshmen, supplemental instruction and career counseling provide the stimulus to attract and retain students in Biological science at the University. Our aim is to develop a Biology program that is a cross between the traditional, course-centered approach to curriculum and a more content- and learning outcome-centered approach. The main questions are: what skills do we expect our students to have developed? How do we adequately approach the question of program and course assessments? How do we track our graduates on a long term basis.

**Poster #78**  
**Category:** A4  
**Primary Project or Approach:** Student Research introduced as an Integral Part of Traditional Courses and Introduction of Technologies New to Biology  
**Institution:** Bellevue College  
**Presenter:** M. Gita Bangera  
**Email:** gita.bangera@bellevuecollege.edu  
**Field of Interest within Biology:** Molecular Biology & Biochemistry  

**Goals & Intended Outcome:** Our goal is to use undergraduate research as a tool to teach students to be self-directed learners. We are exposing students to the excitement of ownership and discovery in research by partnering with USDA scientists to sequence the genomic library of the biological control bacterium P. fluorescens L5.1-96.

**Methods & Strategies:** The basic strategy is a mini-graduate school experience to train students in self-directed learning and critical thinking. Community college students with only basic biology knowledge learn to conduct original research, trouble-shoot experiments, organize journal clubs, and network within the scientific community.

**Evaluation Methods & Results:** We are using a combination of evaluation strategies, some adapted from existing programs and some designed in house. Pre and post surveys track changes in students’
Dissemination Activities & Plans to Disseminate: We are currently carrying out dissemination within Bellevue College, introducing students in introductory biology classes to research by incorporating a plasmid DNA isolation module into the existing curriculum. We are designing an interactive web-based tool along with lab material packages for external dissemination.

Impacts of Project or Anticipated Impact: The greatest impact observed so far has been in the students' attitudes and approach to science. Students have shown higher levels of commitment and motivation as seen by hours spent in lab on non-class days and weekends and continuing journal clubs on their own after having completed the course. Intense student interest has prompted the implementation of a second course to allow them opportunities to continue their research past the first quarter. Based on this result, we are planning to introduce this teaching method to graduate students and post-docs thereby impacting future educational practices.

Challenges: The biggest challenge has been communicating to potential students the availability and nature of this course. Not being part of a standardized list of required courses, there has been some self-selection in the students attending this course. We are planning on using the college's website, email and social networking sites to attract a larger and a more diverse pool of students. We are also planning to set up articulation agreements with local universities for transfer of credits from this course.

Poster #79
Category: A4
Primary Project or Approach: Student Research introduced as an Integral Part of Traditional Courses and Introduction of Technologies New to Biology
Institution: Benedictine University
Presenter: Peter Nelson
Email: pnelson@ben.edu
Field of Interest within Biology: Biophysics

Goals & Intended Outcome: The goal of the project is to develop modules for teaching selected topics in biophysics and physiological modeling. As the approach and topics are new, the modules are being written in the style of self-study guides (or workbooks) that students can complete without additional assistance. As part of the project the modules will be disseminated to others for beta-testing, evaluation, revision and adoption.

Methods & Strategies: The modules use Microsoft Excel as the compute engine. This enables them to be implemented at a wide range of institutions and requires only an inexpensive PC and standard software. Using the modules as directed self-study guides, students write their own spreadsheets from scratch and discover for themselves the consequences of the model assumptions. Once the spreadsheet is working, students answer a series of questions requiring careful analysis of the spreadsheet’s graphical output.

Evaluation Methods & Results: Evaluation focuses on student impact, collateral benefit to the student’s subsequent course-based learning and degree completion, and longitudinal impact upon the student’s success in attaining appropriate employment in the biophysics community. Outcomes-based assessment utilizes a Solomon multi-group design. Two (2) distinct interventions XA (construct devel-
opment within a calculus-prerequisite Biophysics course) v. XB (construct development within a calculus-non/prerequisite Biophysics course)) will be tested for student course achievement impact. The chronological timeline for formative and summative evaluation will be based upon the cohort (students), and their participation in the appropriate physical science or life science course.

**Dissemination Activities & Plans to Disseminate:** This project has just begun (summer 2009). The plan is for volunteer instructors to beta test selected modules. In order to maximize the potential impact of the material being developed the work is being presented: at a variety of national conferences in areas such as biology, physics, biochemistry and physiology; in articles submitted to appropriate journals in these same disciplines; and is being considered for dissemination through the Biological ESTEEM Collection, a project of the BioQuest Curriculum Consortium, a consortium that disseminates peer-reviewed Excel simulations to biology and mathematics educators.

**Impacts of Project or Anticipated Impact:** The materials developed in this project are being used by in two courses currently taught at Benedictine University. “Biophysics 323” is a calculus-based course that is required for all BMB majors at BU. BIOL 310 “Biophysics and Physiological Modeling” is an algebra-based, 300-level elective course. The module topics should appeal to biology and pre med students. The topics covered are suitable for Cell Biology and Physiology courses, but it’s hoped that they will eventually be used in stand-alone Biophysics or Physiological Modeling courses. Quantitative modeling and experimental data analysis have been identified areas that need new materials e.g. NRC’s “Bio2010: Transforming Undergraduate Education for Future Research Biologists” and the AAMC-HHMI committee report “Scientific Foundations for Future Physicians”

**Challenges:** This project has just begun (summer 2009). The main challenge I foresee is finding instructors willing to try something new and to teach quantitative topics that are not usually taught to undergraduate biology students.

**Abstract:** Teaching Biophysics and Physiological Modeling without Calculus

A new approach is presented for teaching undergraduate students advanced topics in biophysics, even if they have no calculus. Students are introduced to molecular simulation, modeling and computational techniques using Microsoft Excel as the compute engine. Starting with a blank spreadsheet, students develop their own kinetic Monte Carlo (kMC) simulations and finite difference (FD) models of membrane transport from scratch. In a directed approach, students discover for themselves the qualitative and quantitative consequences of the model assumptions. This model is applied to a wide variety of physiological systems ranging from single molecules (e.g. ion channel gating) up to the whole organism (e.g. drug elimination). Simple models of ion channels and aquaporins provide kinetic explanations for thermodynamic properties such as the Nernst potential and osmotic pressure. Many other topics can be investigated using a similar approach including: distribution of O2, CO2 and glucose; fluid dynamics and blood flow; kinetics of motors, carriers, and RNA; membrane transport and drug delivery; diffusion of neurotransmitters; and ion channel permeation and the action potential. Whenever possible, model predictions are tested by graphical comparison with experimental (or clinical) data.

**Poster #80**  
**Category:** A4  
**Primary Project or Approach:** Student Research introduced as an Integral Part of Traditional Courses and Introduction of Technologies New to Biology  
**Institution:** Birmingham-Southern College  
**Presenter:** Leo Pezzementi  
**Email:** lpezzeme@bsc.edu
Co-Presenter: Pamela Hanson

Field of Interest within Biology: Bioinformatics

Goals & Intended Outcome: According to BIO 2010, Quantitative analysis, modeling, and prediction play increasingly significant day-to-day roles in today’s biomedical research. "Biology students should be prepared to carry out in silico (computer) experiments to complement in vitro and in vivo experiments."

Methods & Strategies: To address this need, we have developed molecular modeling modules that bridge biology and chemistry courses. Molecular modeling software is used by students (1) to aid in visualization of molecular structures and (2) to facilitate development of hypotheses that can be tested in "wet" labs. Modules have been developed for our General Chemistry (CH 121), Cell and Molecular Biology (BI 125), Organic Chemistry (CH 212), Physiology (BI 303), Physical Chemistry (CH 311) and Biochemistry (BI/CH 408) courses.

Evaluation Methods & Results: Anonymous surveys reveal that molecular modeling modules are having the anticipated impact. For example, during the first semester of implementation, 92% of Cell and Molecular Biology students agreed or strongly agreed that molecular modeling helped them visualize what an active site looks like.

Dissemination Activities & Plans to Disseminate: Presentations have been made at an NSF-PI workshop, at Trinity University (Texas), and at a PALM Workshop at the Milwaukee School of Engineering. Publication in a peer-reviewed journal is planned.

Impacts of Project or Anticipated Impact: When surveyed, most students reported that molecular modeling facilitated their paper-writing. Furthermore, the percentage of students who explicitly discussed the structure-function relationships that dictate substrate and inhibitor specificity increased upon implementation of the molecular modeling portion of this lab series.

Challenges: There were problems with the synthetic part of the laboratory in Organic Chemistry and the synthesis was deleted.

Abstract: Enhancing Multidisciplinarity through Molecular Modeling

According to BIO 2010, "Quantitative analysis, modeling, and prediction play increasingly significant day-to-day roles in today’s biomedical research. Biology students should be prepared to carry out in silico (computer) experiments to complement in vitro and in vivo experiments." To address this need, we have developed molecular modeling modules that bridge biology and chemistry courses. Molecular modeling software is used by students (1) to aid in visualization of molecular structures and (2) to facilitate development of hypotheses that can be tested in "wet" labs. Modules have been developed for our General Chemistry (CH 121), Cell and Molecular Biology (BI 125), Organic Chemistry (CH 212), Physiology (BI 303), Physical Chemistry (CH 311) and Biochemistry (BI/CH 408) courses. Relationships between concepts presented in these courses are made explicit through activities which focus on the same small molecule, namely, the nerve agent sarin. Here we present the results of our BI 125 curricular changes. In this course, students using modeling software to visualize how sarin binds to the serine in the active site of acetylcholinesterase (AChE). Students also compare and contrast the structures of AChE and butyrylcholinesterase (BChE), model several cholinesterase inhibitors, and use the data they obtain to determine which inhibitors target AChE and which inhibit BChE. They subsequently apply this information to design an experiment to determine which cholinesterase (AChE or BChE) is in horse serum. Anonymous surveys reveal that molecular modeling modules are having the anticipated impact. For example, during the first semester of implementation, 92% of Cell and Molecu-
lar Biology students agreed or strongly agreed that molecular modeling helped them visualize what an active site looks like.

**Poster #81**  
**Category:** A4  
**Primary Project or Approach:** Student Research introduced as an Integral Part of Traditional Courses and Introduction of Technologies New to Biology  
**Institution:** Boston College  
**Presenter:** Clare O’Connor  
**Email:** oconnocn@bc.edu  
**Co-Presenter:** Arlene Wyman and John P. Wing, Boston College  
**Field of Interest within Biology:** Cell Biology  

**Goals & Intended Outcome:** Our project involves students in original functional genomics research in advanced laboratory classes. Students from three lab classes in biochemistry, cell biology and molecular biology work collaboratively on an interdisciplinary theme focused on enzymes that repair oxidative damage to proteins.

**Methods & Strategies:** Classes are designed to emulate a research laboratory environment. Two or three-member student teams design and conduct original experiments around the class theme. Teams regularly discuss and analyze their results with other teams in their classes, and students make presentations to the other classes as well.

**Evaluation Methods & Results:** We have worked with colleagues in the Lynch School of Education to develop pre- and post-course surveys as well as observation and interview protocols. Surveys and protocols are designed to test student competencies in the scientific process, information literacy, technical skills, teamwork and communication. Evaluation results over four semesters indicate significant student progress toward the course goals. These protocols continue to be refined after each semester. Students express confidence about their abilities and enthusiasm about participating in original research, and some enroll in additional classes.

**Dissemination Activities & Plans to Disseminate:** The project website (Boston College Biology Commons) includes class information, protocols, and tutorials. The site uses file formats that can be accessed from multiple platforms and are projected to have longevity. Other results will be published in scientific and educational journals within the next 1-2 years.

**Impacts of Project or Anticipated Impact:** This project provides a model for engaging large numbers of students to original research in departments confronted with high student to faculty ratios. Student satisfaction is evident in the number of students who enroll in multiple lab courses or continue their experiments in independent study projects. Over the course of multiple semesters, classes have identified new phenotypes that will add to the science knowledge base. The biology department has embraced this model of laboratory research courses and is introducing new research classes in the fields of neurobiology and aquatic molecular ecology.

**Challenges:** The sequential nature of the project represents a major challenge, since class experiments build on results generated during the previous semester. Students need to learn basic techniques during the early part of the semester, so time for collecting new results is limited. Classes are continually challenged to interpret new results as they arise. Each class also represents a new mix of personalities that need to be organized into effective teams. Integrating multiple classes is another challenge. Finally, differences in teaching philosophies add complexity to project evaluation.
Poster #82
Category: A4
Primary Project or Approach: Student Research introduced as an Integral Part of Traditional Courses and Introduction of Technologies New to Biology
Institution: Brandeis University
Presenter: Susan Lovett
Email: lovett@brandeis.edu
Co-Presenter: James R. Morris, Brandeis University and Jessie Stickgold-Sarah, Brandeis University
Field of Interest within Biology: Genetics

Goals & Intended Outcome: The goal of our project was to develop a sustainable research-based undergraduate course in genetics and genomics. The intended audience was upper-level students in the biological sciences that had not been previously engaged in research. The course has been taught for three years, using bacterial and fruitfly genetic systems.

Methods & Strategies: Through a series of lab activities, we move students from a "cookbook" lab into self-directed research in three steps: a class-wide training exercise with the genetic system, a group set of research experiments with unknown outcome and a student-designed final experiment. We have developed a set of exercises to move students through the process of reading and then writing a scientific paper.

Evaluation Methods & Results: Student attitudes were assessed initially by "homegrown" questionnaires and later, pre and post-course surveys using the HHMI-developed CURE instrument from Lopatto et al. at Grinnell College. Although we had a small sample, gains were particularly high in understanding the research process, working independently and reported skill in scientific writing. The writing component was also evaluated using a separate online survey, which will be integrated with results from other writing projects across Brandeis University supported by a Davis grant. We are in the process of evaluating and refining the writing exercises for the coming year.

Dissemination Activities & Plans to Disseminate: We plan to publish on-line the training exercises that were used for the bacterial and fruitfly genetic experiments. After our refinement of the writing exercises in the next academic year, we hope to publish our strategies and results for this part of the course development.

Impacts of Project or Anticipated Impact: The course has been very successful for future engagement of students into scientific research, both as undergraduates and after graduation into masters and Ph. D. programs and into the biotechnology industry. Minority students are well-represented in this group. The use of peer teaching assistants (students who took the course in prior years) has also been a positive aspect. We buy that "buy-in" from research faculty is enhanced because the projects can reflect and benefit their research interests. In the future, we hope to expand the course to additional faculty and to genetic systems such as yeast and nematodes. In addition, we plan to interject short research projects into other lab courses and to extend the project lab to non-Biology majors in a summer course.

Challenges: The writing component of the course was particularly challenging and we were surprised that many of the best students needed a great deal of support. For the instructors, this was also a very time consuming part of the course, although our evaluations suggest it was one of the most valuable parts. We are learning what logistical support has to accompany such a course, since what students are doing can get complicated in a research environment. Supportive, flexible and approachable instructors and assistants are more important than experimental plans. Students need some support and general "cheerleading" when experiments fail. However, the experience of trouble-shooting an ex-
Poster #83
Category: A4
Primary Project or Approach: Student Research introduced as an Integral Part of Traditional Courses and Introduction of Technologies New to Biology
Institution: Case Western Reserve University
Presenter: Christopher Cullis
Email: cac5@case.edu
Field of Interest within Biology: Plant Biology & Botany

Goals & Intended Outcome: Introduce students to a real world problem - food security in the developing world. Have them develop resources that will be used to improve a crop for resource poor farmers. Engage them in the possibility of helping in research in the developing country.

Methods & Strategies: The students will learn to apply sophisticated state of the art molecular techniques to a problem that does not have a known answer. The data they generate will be applied in research to improve food security in the developing country. They will interact with the individuals who will use their results.

Evaluation Methods & Results: The evaluation consists of open ended question sets, laboratory reports and an oral presentations plus a review paper on the presentation topic. The question sets model the types of analysis necessary for the two laboratory reports. The reports require an analysis that includes an evaluation with respect to expected outcomes based on comparable published data. A dramatic improvement in the quality of analysis is apparent in the second report compared to the first with the students discomfort with this type of analysis reducing through the course. The presentation develops both speaking and writing skills.

Dissemination Activities & Plans to Disseminate: I gave an invited presentation about this course in the education session at the American Society of Plant Biologists Annual Meeting, June 2008. An article describing the course is being prepared. I have been invited to present about this at an international conference at Rothamsted Research, UK in October 2009.

Impacts of Project or Anticipated Impact: The project has impacted the students by raising their understanding of the research and educational conditions prevailing in developing countries. They have also been challenged to interpret data from their experiments that did not have a predetermined right answer. The model has been extended to develop alternatives to the course that are based on other organisms. The data produced is being used in research grant applications.

Challenges: Class size -- more than 30 students makes difficulties in getting experiments completed without long down times as students wait for access to the apparatus. Ideal limits to the class size are 20-24 students. Making students comfortable with evaluating new data -- Use the time between experimental manipulations to have formal group and full class discussions with equivalent data sets and analysis of what the experimental observations are likely to be.

Abstract: A laboratory course has been designed to engage undergraduate students in developing useful DNA markers for under-utilized crops in Africa while also getting an international experience. This course specifically tries to avoid a common preconception of laboratory courses, namely, if the experiment works then there is not much satisfaction since “the experiments are set up to ensure that they work and there is a definitive answer to the questions posed”. The focus of the course for the
past 4 years has been on developing useful DNA markers, with each class building on previous years’ results. The crops initially targeted were bambara nut, banana, cassava, cowpea and marama, but marama bean (Tylosema esculentum) has now been selected as the focus crop for the next few years. These student efforts should result in a high density SSR molecular map of marama. The international component involves web video links for live interactions between students and faculty in Cleveland, Pretoria and Windhoek, where the data will be put to direct use in a proposed breeding project. Dr. Percy Chimwamarumbe from Namibia was an active participant in the course for two weeks in Fall 2007. A graduate student from Namibia, Emanuel Neopolo, participated in the course for six weeks in Fall 2008. Up to 36 students are enrolled each semester (the course is being offered twice a year) and it has been positively and enthusiastically evaluated by the students. The development of this course was supported by a World-Wide Learning Experience grant, a McGregor Fund initiative in the College of Arts and Sciences, Case Western Reserve University (to CAC) and a grant from the Kirkhouse Trust (to PC).

Poster #84
Category: A4
Primary Project or Approach: Student Research introduced as an Integral Part of Traditional Courses and Introduction of Technologies New to Biology
Institution: Chief Dull Knife College
Presenter: Robert Madsen
Email: bmadsen@cdkc.edu
Field of Interest within Biology: Microbiology, Virology

Goals & Intended Outcome: Develop a student research program that directly reflects some of the material that is taught in 100 & 200 level biology courses and introductory organic & biochemistry courses. The biology courses we are targeting are cell biology and microbiology.

Methods & Strategies: We are in the process of developing an environmental microbiology research program that includes field and laboratory elements. As this program is developed we will incorporate elements of the research into our biology curriculum.

Evaluation Methods & Results: Evaluation includes student interviews, course completions & grades, students participating in student research projects and tracking students when they transfer to four-year institutions.

Poster #85
Category: A4
Primary Project or Approach: Student Research introduced as an Integral Part of Traditional Courses and Introduction of Technologies New to Biology
Institution: Claremont McKenna, Pitzer, and Scripps Colleges
Presenter: Emily Wiley
Email: ewiley@jsd.claremont.edu
Field of Interest within Biology: Molecular Biology & Biochemistry

Goals & Intended Outcome: To provide original research opportunities in the classroom and a means for disseminating students' novel discoveries to a broader group of interested research scientists. Connecting students with a large community research initiative increased their effort, interest in learning, confidence as viable contributors in a research community, and interest in pursuing additional research opportunities beyond class.
Methods & Strategies: We have developed scaleable research modules for easy integration into existing molecular/cell biology courses that allow students to generate new information on the structure and function of predicted genes in Tetrahymena thermophila. Student results are disseminated to the broader research community through an interactive database/website linked to the official Tetrahymena Genome Database.

Evaluation Methods & Results: Evaluation methods so far have consisted of self-designed pre- and post class surveys (subject, attitudinal, and confidence surveys), published surveys (Survey of Undergraduate Research Experiences), post-graduation surveys, tracking student participation in research within the next two years following the course, tracking voluntary student time spent on the research project outside of class, and monitoring performance on scientific presentations (written and oral). Future plans include more extensive use of SURE assessment and interviews of graduates five years out.

Dissemination Activities & Plans to Disseminate: A complete description of the project and available modules for integration into existing courses are available on the Ciliate Genomics Consortium database/website (www.tet.claremont.edu). A training workshop for faculty (9) to use the research modules and join the consortium was offered last year. Future workshops will be offered annually. The project and modules will be published in education journals.

Poster #86
Category: A4
Primary Project or Approach: Student Research introduced as an Integral Part of Traditional Courses and Introduction of Technologies New to Biology
Institution: Emory University
Presenter: Victor Corces
Email: vcorces@emory.edu
Field of Interest within Biology: General Biology

Goals & Intended Outcome: RISE is an HHMI-supported program with the goal of introducing underprivileged students from the Atlanta public schools to original research in the biological sciences. The ultimate goal of the program is to excite the students about college careers that involve research in modern biology.

Methods & Strategies: All students work on the same project, which involves the identification and characterization of proteins involved in nuclear organization. Studnets start by carrying out a genetic screen of GFP protein fusion traps in Drosophila. Once they identify a protein of interest, they carry out a complete characterization, which involves bioinformatics, cell and molecular biology.

Evaluation Methods & Results: All students attend college. Some are accepted to highly selective universities where they continue to be involved in laboratory research.

Dissemination Activities & Plans to Disseminate: We have a web site http://www.biology.emory.edu/research/Corces/RISE/RISE.html

Impacts of Project or Anticipated Impact: Students involved in the RISE program become motivated to attend college. The program has become well-known among Atlanta public schools, which compete to have their students participate in RISE. Within each participating school, RISE is known by all students and participation in the program is viewed as an honor. RISE requires participating schools to have a science fair every year, increasing involvement of all students in science projects. RISE stud-
nets have won the Atlanta science fair twice and won 2nd and 3rd places in the Georgia State fair this year.

**Challenges:** Students lack knowledge of biology because most public schools do not offer AP biology. We now offer students a college-level General Biology class as well as SAT preparation classes in the summer.

**Abstract:** RISE is an HHMI-supported program with the goal of introducing underprivileged students from the Atlanta public schools to original research in the biological sciences. The ultimate goal of the program is to excite students about college careers that involve research in modern biology. Students enter the program during the summer of the sophomore year and stay until the summer after graduation, working in the lab everyday during the academic year from 1-6 and 9-6 during the summer. Students work on a research project related to the main interest of the rest of the lab, mentored by undergraduates, graduate students and postdocs. Students start by carrying out a screen of GFP protein traps for proteins expressed in interesting patterns in the nucleus; groups of 3-4 students then work on the characterization of specific proteins using a combination of molecular, cellular and computational approaches. Because of the nature of the initial research, the students are able to learn at an appropriate pace and understand the significance of the results. In addition to their involvement in their research project, we provide them with an AP Biology class, SAT training and help with the college application process. If they are accepted into the Emory undergraduate program, they receive a full tuition scholarship and they continue working during their undergraduate career while serving as role models for the high school students. Graduates of the program have gone on to Stanford, Duke, Cornell and Emory.

**Poster #87**
**Category:** A4
**Primary Project or Approach:** Student Research introduced as an Integral Part of Traditional Courses and Introduction of Technologies New to Biology
**Institution:** Hiram College
**Presenter:** Brad Goodner
**Email:** goodnerbw@hiram.edu
**Field of Interest within Biology:** Microbiology, Virology

**Goals & Intended Outcome:** Our goals are to involve undergraduates in novel within-course research projects in order to (1) excite them about the current state of biology, (2) teach basic scientific concepts, principles, and skills, and (3) encourage students to seek out further research experiences beyond the classroom.

**Methods & Strategies:** Beginning with 3 faculty and staff in 2002, and now involving over 15 faculty and staff across several departments, we encourage and support our faculty/staff members to incorporate cutting-edge research projects into the laboratory components of their courses and connect these projects to their own research.

**Evaluation Methods & Results:** Over the last 4 years alone, within-course research was incorporated into 33 total iterations of 15 different courses that involved 197 different students in a total of 877 research-within-course contacts. Based on student assessment of 4 of these courses, students reported that the within course research helped a) their overall learning experience (83-93%), b) their understanding of the research process (69-97%), c) their understanding of scientific concepts, principles, and skills (56-78%), d) increase their self-confidence (76-87%), and e) them make career decisions (90-95%).
Dissemination Activities & Plans to Disseminate: Our faculty and students have published re- search articles and presented at meetings on research that began with or was solely done within courses. We have also published curricular pieces on within-course research projects and taken part in several national initiatives on undergraduate genomics research.

Impacts of Project or Anticipated Impact: Over the last 4 years alone, within-course research was incorporated into 33 total iterations of 15 different courses that involved 197 different students in a total of 877 research-within-course contacts. A high percentage of our students have gone on to be involved in independent research projects on our campus and elsewhere. Our faculty and students have published research articles and presented at meetings on research that began with or was solely done within courses. We have also published curricular pieces on within-course research projects and taken part in several national initiatives on undergraduate involvement in genomics and bioinformatics research.

Challenges: Our biggest challenge, and it is continual, is consistent funding of undergraduate in- volvement in novel research within courses. This falls between the cracks of current funding both by government and non-government entities who either want a research-only focus but cannot see undergrads as the main driver of such research OR who want to focus solely on educational pedagogy and assessment. There is great value in a 3rd path, currently unavailable, of supporting high-quality undergrad-driven biological research.

Abstract: Genomics Research & Undergraduate Education – A Value-Added Collaboration in Both Di-rections

Integrating original research into a course is an effective way to connect students to the current state of understanding, encourage them to take more control of their own learning, and promote problem solving and interdisciplinary learning. Over the past 8 years at Hiram College, we have integrated ge- nome annotation, functional genomics and metagenomics into Molecular and Cellular Biology, Genet- ics, and Microbiology courses. Working in teams, students have complemented the usual automated first-pass annotation (gene localization and identification through similarity) by reconstructing bi- chemical pathways to verify gene-protein relationships and to identify novelties and redundancies, by predicting regulatory networks based on gene order and shared non-coding sequences, by identifying possible instances of lateral gene transfer based on gene phylogenies, and by comparing large gene sets across genomes to test various hypotheses. We will highlight the work done by the 2007-2009 iterations of these courses which include our participation in the U.S. Department of Energy Joint Ge- nome Institute IMG-ACT pilot program and in conducting faculty development programs in bioinfor- matics sponsored by the American Society for Microbiology and the Joint Genome Institute.

It is also important for students to see genome annotation not only as answers to some past questions but also as generators of new testable hypotheses which can often be addressed by undergraduates and even high school students. For example, students in the Molecular & Cellular Biology course have used reverse genetics to test functional predictions based on bioinformatics analyses of over 75 genes in Agrobacterium tumefaciens. Students in the Genetics course, along with high school students dur- ing the past several years, have used forward genetics to link hundreds of genes to functions through large scale transposon mutant hunts in A. tumefaciens, Chromohalobacter salexigens, and Acidovorax avenae subsp avenae. More recently, Genetics students have used functional complementation of known E. coli mutants to find functional homologs from known genomes and from metagenomes. Fi- nally, summer research students have used comparative genomic data to design PCR primers targeted for different phylogenetic groups as part of an ecological metagenomics project. These primers were successfully tested in the Genetics course and will contribute to future Microbiology courses and high school outreach projects. We will highlight some of the more interesting findings in several functional categories.
Poster #88  
Category: A4  
Primary Project or Approach: Student Research introduced as an Integral Part of Traditional Courses and Introduction of Technologies New to Biology  
Institution: Howard Hughes Medical Institute  
Presenter: Tuajuanda Jordan  
Email: jordant@hhmi.org  
Co-Presenter: David Lopatto, Grinnell College  
Graham Hatfull and Deborah Jacobs-Sera, Univ. of Pittsburgh  
Lucia Barker, Kevin Bradley, Razi Khaja, Melvina Lewis, Howard Hughes Medical Institute  
Field of Interest within Biology: General Biology

Goals & Intended Outcome: Goal: To expose college freshmen to the process of doing science via an authentic research experience implemented as part of the curriculum. Intended outcomes: develop wet and computational lab skills; enhance student critical thinking, analytical, and communication skills.

Methods & Strategies: Lead scientist poses a question of the year, faculty at institutions across the country direct freshmen who formulate hypotheses, design experiments using techniques/tools of microbiology, molecular biology, electron microscopy, and bioinformatics, and interpret data.

Evaluation Methods & Results: Students were 1) evaluated versus comparison groups using electronic pre- and post-survey instruments designed to a) measure changes in student attitudes and behavior about science and b) basic knowledge of biology and 2) compared to the typical student in the introductory biology lecture course at the respective institution.

Dissemination Activities & Plans to Disseminate: The overview data have been disseminated at three national scientific conferences and one national conference focused on science education. The scientific data have been submitted to GenBank. There are plans to disseminate the scientific and pedagogy-focused data via peer-reviewed journals.

Impacts of Project or Anticipated Impact: Student impacts: enhanced engagement in and enthusiasm for science and scientific research; higher percentage of novices seeking research-related activities post-freshman year; higher percentage of novices (freshmen) making scientific presentation at local, regional and national conferences and symposia. Faculty/institutional impacts: faculty designing ways to infuse research in other laboratory courses; faculty incorporating results from the freshman course into higher level courses; institutions investigating ways to offer the course to a larger number of students.

Challenges: Challenges were associated with maintaining the sense of community for a group of scientists scattered across the country. Implemented a "Question of the Week" to engage the students to get them thinking about science beyond phage genomics. The first student from each institution to submit the best answer to the question received a prize and had her/his name posted on the wiki. For the faculty, created a private section on the wiki where they could discuss scientific and/or pedagogical triumphs, challenges, and solutions.

Abstract: A Model Introductory Laboratory Course – The HHMI Science Education Alliance’s National Genomics Research Initiative

A goal of Howard Hughes Medical Institute’s Science Education Alliance (SEA) is to have research scientists and science educators work together to improve the production and quality of 21st-century scientists. The SEA’s first offering is the National Genomics Research Initiative (NGRI), a collaborative in
which a lead scientist poses a question of the year and networked faculty across the country direct college freshmen in an authentic research experience as part of their curriculum. These novices were exposed to the process of doing science. The NGRI course is based upon Graham Hatfull’s Phage Hunters program at the University of Pittsburgh. In its inaugural year, 12 diverse institutions implemented the NGRI laboratory course either as a substitute for or in addition to the standard introductory biology laboratory course; targeting their typical entering freshmen, freshmen classified as at-risk, freshmen entering with either AP Biology credit or admitted into the honors college.

These 270 students used techniques in microbiology, molecular biology, and electron microscopy to isolate and preliminarily characterize 234 new mycobacteriophage. We designed a unique bioinformatics workflow that facilitated the freshmen annotation of the 12 phage genomes that were sequenced. By the end of the academic year, eight completely annotated genomes were submitted to GenBank. In this first year, we observed: 1) higher student retention in the NGRI course relative to the standard introductory biology laboratory course (94% vs. 88%); 2) higher introductory biology lecture course average (6 points) than non-NGRI students; and 3) gains in student behavior and attitudes about science consistent with national trends. The data suggest that we have a model for science education that produces positive results regardless of the target freshman population, implementation strategy, or resources available to the institution.

**Poster #89**

**Category:** A4

**Primary Project or Approach:** Student Research introduced as an Integral Part of Traditional Courses and Introduction of Technologies New to Biology

**Institution:** Jackson State University

**Presenter:** Tor Kwembe

**Email:** tor.a.kwembe@jsu.edu

**Co-Presenter:** Hyun J. Cho, Zhenbu Zhang, Raphael Isokpehi, Jackson State University

**Field of Interest within Biology:** Marine and Coastal Science, Bioinformatics, Genetics and Physiology

**Goals & Intended Outcome:** This project is designed for mathematics and biology students or other science students with interest in mathematics or biology who are interested in the application of mathematics to biology. Participating students take courses designed to strengthen the mathematical knowledge and skills of biology majors, and increase the ability of mathematics majors to use their quantitative skills to solve biological problems.

**Methods & Strategies:** They participate in a five-week summer intensive course at a National Laboratory where they collaborate on fisheries science projects and also take courses in marine and coastal science. Finally, students take part in collaborative research work at JSU during the academic year for a minimum of two years under the supervision of faculty teams from biology and mathematics departments.

**Evaluation Methods & Results:** The success of the interdisciplinary training program of students in mathematics and biology is evaluated using a number of instruments. Participants are given entry questionnaires to assess their background and expectations of the program. A mid-program assessment and an exit questionnaire are also administered to assess whether the program has significantly impacted them sufficiently to pursue graduate studies in mathematical biology or quantitative sciences. Feedback from students with respect to the organization and content of the program is used to modify the program in subsequent years.

Impacts of Project or Anticipated Impact: Participants have been retained in the College of Science, Engineering, and Technology (CSET) and those that have graduated are either attending graduate school in a STEM area or are employed in a STEM career path. The program has contributed to an increase in interdisciplinary research activities among participating faculty and students. The broader impact of the program is also evidenced by request from institutions that participants have been placed for graduate work to recommend more students for their graduate programs. The proposed curriculum changes in the biology and mathematics departments.

Challenges: The high interest in the program by biology majors. Through innovative processes and procedures, we increased the number of participants over the funded numbers.

Abstract: UBM: Interdisciplinary Training of Undergraduates in Biological and Mathematical Sciences with Emphasis on Marine and Coastal Science

This project is designed for mathematics and biology students or other science students with interest in mathematics or biology who are interested in the application of mathematics to biology. Participating students take courses designed to strengthen the mathematical knowledge and skills of biology majors, and increase the ability of mathematics majors to use their quantitative skills to solve biological problems. They participate in a five-week summer intensive course at a National Laboratory where they collaborate on fisheries science projects and also take courses in marine and coastal science. Finally, students take part in collaborative research work at JSU during the academic year for a minimum of two years under the supervision of faculty teams from biology and mathematics departments. This interdisciplinary training of students focuses on population biology with emphasis on marine/coastal science. However, students also have opportunities to conduct research in other areas of biology and biomathematics.

Poster #90
Category: A4
Primary Project or Approach: Student Research introduced as an Integral Part of Traditional Courses and Introduction of Technologies New to Biology
Institution: Juniata College
Presenter: Michael Boyle
Email: boyle@juniata.edu
Co-Presenter: Randy Bennett, Jill Keeney, and Vincent Buonaccorsi, Juniata College
Field of Interest within Biology: Bioinformatics

Goals & Intended Outcome: To incorporate bioinformatic analysis of raw sequence data into open-ended student inquiry.
**Methods & Strategies:** Initially a research approach will focus on data analysis in support of testing a research hypothesis. This will be followed with selective integration of raw sequence data into teaching modules to be used in multiple classes (introductory to 400 level) taught by faculty from different areas of biology.

**Evaluation Methods & Results:** The initial focus will be to determine, relative to historic controls, the number of students applying to graduate research programs in the life sciences. As related teaching modules are developed, each will be assessed for measurable improvement in understanding and integrating molecular biology concepts into diverse subject areas. Evaluation of critical thinking and methodology will be determined using analysis of raw data within a given scientific scenario. The ability to apply concepts learned in one class to problems related to another will be a critical measure to determine how well the approach leads to identification and understanding of core concepts in biology.

**Dissemination Activities & Plans to Disseminate:** As data is accumulated, it will be analyzed and gains in student learning will be assessed. The results will be disseminated through presentations at undergraduate education meetings e.g. ASMCUE as well as through publications in appropriate journals. Efforts will be made to form a community of colleagues who are using a similar approach. This will be modeled after the GCAT program.

**Impacts of Project or Anticipated Impact:** The initial focus will be to determine, relative to historic controls, the number of students applying to graduate research programs in the life sciences. As related teaching modules are developed, each will be assessed for measurable improvement in understanding and integrating molecular biology concepts into diverse subject areas. Evaluation of critical thinking and methodology will be determined using analysis of raw data within a given scientific scenario. The ability to apply concepts learned in one class to problems related to another will be a critical measure to determine how well the approach is working.

**Challenges:** The major challenge is to identify the initial funding to provide the raw sequence data for the proposed approach. Subsequent challenges that we anticipated include the challenge of organizing large data sets and keeping track of the analysis that has been performed by one student and how to integrate related data generated by many students. Solving this challenge will be key to allowing students to join ongoing classes focused on some aspect of the research being conducted by individual faculty as well as to move between different classes or continue with a project that incorporates and validates the work of others. We anticipate there will be a role for our IT faculty who are skilled in developing and managing data in different contexts.

**Abstract:** Transforming Undergraduate Education Through Increased Faculty Access to NextGen Sequencing Runs.

Raw nucleotide sequences are currently being provided, as part of a national genomics research initiative, to a limited number of investigators at undergraduate institutions to promote research and teaching. This initiative could be much more effective if the source of the sequenced material and the subsequent focus of the data analysis were investigator-initiated. This approach could be easily accomplished at low cost by judicious use of the surplus capacity in existing nucleotide sequencing cores to generate raw sequence data to support ongoing research efforts at small undergraduate colleges. This approach would stimulate student training in modern biology, and overcome the major hurdle for faculty as small liberal arts colleges to initiate engagement in next generation sequencing: cost of runs. An example of how this could affect research and curriculum is outlined. This pedagogic approach would stress integration of basic biological concepts and modern bioinformatics, with the multiple disciplinary angles that reflect actual faculty interests. It would also provide students with a fundamental understanding of the interacting network of genes and proteins, and provide avenues for an engaging introduction to systems biology. Thus with a relatively modest investment within the existing scientific
infrastructure, successful programs focused on pre-selected areas of research could be much more broadly expanded into investigator-oriented research areas. We aim to model a process whereby an investigator’s innate passion for research combined with relevant raw sequence data is channeled into timely and effective student training at small colleges.

**Poster #91**  
**Category:** A4  
**Primary Project or Approach:** Student Research introduced as an Integral Part of Traditional Courses and Introduction of Technologies New to Biology  
**Institution:** Lansing Community College  
**Presenter:** Melinda R. Wilson  
**Email:** mindy.wilson@lcc.edu  
**Co-Presenter:** Thomas L. Deits, Lansing Community College  
Kevin Worden, Lansing Community College  
**Field of Interest within Biology:** Biotechnology  

**Goals & Intended Outcome:** The goals of our project were: a) to determine the skill sets needed, by our applied science degree students, to be successful in advanced technology workplaces and b) develop a course to teach students the required skill sets needed in advanced technology workplaces.

**Methods & Strategies:** Our first goal was accomplished by developing a survey instrument for advanced technology workplaces in our geographical area. Industrial, academic, private, and government laboratories were personally interviewed. Learning outcomes for "The Advanced Technology Workplace" were determined based upon interviews.

**Evaluation Methods & Results:** Based upon "industry" surveys and personal interviews, four main areas of concern were: 1) Safety and Security, 2) Process control, 3) Legal, Ethical, and Social Skills, 4) Fundamental math and science skills. These areas became the basic framework for developing "The Advanced Technology Workplace" course. Specific learning outcomes were determined within each of the four categories again with industry input.

**Dissemination Activities & Plans to Disseminate:** The course was piloted during two separate semesters and was developed into the course designated as ISCI 275: "The Advanced Technology Workplace" offered at Lansing Community College, Lansing, Michigan.

**Impacts of Project or Anticipated Impact:** It is hoped that our applied science degree graduates will exceed employer expectations in their knowledge of advanced technology workplaces. Although there has not yet been sufficient time to assess impact, preliminary reports indicate students are better prepared to work in regulated, technical environments.

**Challenges:** Context of delivery of course content is an evolving process. During our two pilot semesters, adjustments were made to specific delivery methods.

**Poster #92**  
**Category:** A4  
**Primary Project or Approach:** Student Research introduced as an Integral Part of Traditional Courses and Introduction of Technologies New to Biology  
**Institution:** New Mexico Tech  
**Presenter:** Rebecca Reiss
Email: reiss@nmt.edu  
Co-Presenter: Peter Guerra, AMEC Inc.  
Field of Interest within Biology: Bioinformatics

**Goals & Intended Outcome:** Our goal is to expose students to the multidisciplinary nature of evolutionary informatics research through participation in a research project that will replace traditional pedagogy in an advanced genetics course. We expect students to gain skills in conducting and publishing collaborative research.

**Methods & Strategies:** Metagenomic Monitoring of Microbial Community Evolution in a Tetrachloroethene Contaminated EPA Superfund Site involves the application of Solexa-Illumina next-generation DNA sequencing to aquifer microbes pre- and post- bioaugmentation protocols. Students will read a report prepared for the EPA and choose an element of the research and produce a literature review. They test hypotheses using Alpheus software or develop new algorithms, then write their results in the form of public databases and/or manuscripts for publication.

**Evaluation Methods & Results:** Student learning will be gauged through Student Assessment of Learning Gains (SALG) instruments designed to evaluate changes in the knowledge, skills, and attitudes of course participants before, during, and after the course. We will also track the acceptance rates of student-authored publications and funded research projects that result.

**Dissemination Activities & Plans to Disseminate:** We will disseminate project results through Internet sites and peer-reviewed publications. This will include student-produced publications on the scientific results as well as reports on the efficacy of this pedagogy to improve student and faculty learning.

**Impacts of Project or Anticipated Impact:** This is a multidisciplinary project that will involve faculty and students in biology, chemistry, computer science, environmental science, engineering, and technical writing.

**Challenges:** The transition from standard undergraduate lecture course to a real research experience can be daunting for some students since students are expected to take responsibility for their own education. We will make the expectations clear for the course and provide assistance for students who have difficulty with this transition.

**Abstract:** Research Experience in the Classroom: Metagenomic Monitoring of Microbial Community Evolution in a Tetrachloroethene Contaminated EPA Superfund Site.

Next generation sequencing is here now and it is time to train the next generation of scientists for the age of evolutionary informatics. At New Mexico Tech, we will introduce students to scientific research and the benefits of collaborative learning by focusing on the recently-funded research project, Metagenomic Monitoring of Microbial Community Evolution in a Tetrachloroethene Contaminated EPA Superfund Site. The North Railroad Avenue Plume (NRAP) Superfund Site in Española, New Mexico is contaminated with the chlorinated solvent tetrachloroethene (perchloroethylene or PCE). PCE is a possible carcinogen that threatens the drinking water supply of Española, the Santa Clara Pueblo, and surrounding areas. The Site is currently undergoing augmentation that creates favorable environmental conditions for degrading microbial consortia.

This site provides a unique opportunity to monitor the evolution of microbial communities in response to the selective pressure of the remediation efforts through metagenomic analysis. AMEC, an environmental engineering company contracted to carry out the remediation, facilitated sampling of wells just prior to bioaugmentation in June, 2007, five months later, and 2 years later. Total microbial DNA was
extracted at New Mexico Tech (NMT) for sequencing at the National Center for Genome Resources (NCGR) sequencing center, which consists of eight Illumina® (Solexa) Genome Analyzer II instruments. Previous low resolution analytical procedures have indicated that at least three dechlorinating genera are present at this site: Dehalococcoides, Desulfuromonas, and Dehalobacter.

Complete genome sequences of the first two genera will serve as reference sequences for next-generation sequencing. Students taking the Advanced Genetics course (Biol 411/511) in the Fall of 2009 will work on this project. Our goal is to produce student-authored manuscripts for peer-reviewed publications.

**Poster #93**

**Category:** A4

**Primary Project or Approach:** Student Research introduced as an Integral Part of Traditional Courses and Introduction of Technologies New to Biology

**Institution:** North Carolina State University

**Presenter:** Carla Mattos

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**Field of Interest within Biology:** Molecular Biology & Biochemistry

**Goals & Intended Outcome:** This project stems from a conviction that research and science education are intimately linked and that efforts in effective teaching translates into high interest in research. The goal of this project is to decrease the barrier that currently exists between students in the classroom and research in the laboratory. The intended outcome is that students will be excited about science and pursue further studies in this area.

**Methods & Strategies:** Model building and refinement of the crystal structures have been integrated into an undergraduate course on protein structure and function and into a graduate course on macromolecular modeling. The students taking these courses work closely with the research team in my laboratory to complete the refinement of the structures.

**Evaluation Methods & Results:** Students are evaluated using a mix of conventional testing of the material, lab reports and a PowerPoint presentation to the class describing their research results. More long term criteria includes an assessment of continuing research interests and longer term commitment to sciences. To this purpose we keep track of which students go to graduate school, medical school and other professional programs indicative of intention of developing science-related careers.

**Dissemination Activities & Plans to Disseminate:** Students that make meaningful and significant contribution to our research are included as authors or in the acknowledgments in our publications. In addition, the students are encouraged to present posters at the NCSU undergraduate symposium and a subset get to participate in regional or national meeting.

**Impacts of Project or Anticipated Impact:** The major impact is that a large percentage of my undergraduate students have joined graduate programs at prominent research universities in the United States and the most are excited about career in the sciences. The students make an immediate connection between what they are learning in the classroom and the associated research project.

**Challenges:** A major component of this project is the one-on-one time that the students get with me, my graduate students and more senior members of the laboratory. Sometimes that has been overwhelming. It is a challenge particularly to the graduate students involved, as they need to develop mentoring skills (which is ultimately and excellent advantage in their training) and to manage their
time effectively. My graduate students and postdocs ultimately see the advantage of training the undergraduates, because they usually end up with at least one long-term well-trained undergraduate contributing significantly to some aspect of their project.

Poster #94  
Category: A4  
**Primary Project or Approach:** Student Research introduced as an Integral Part of Traditional Courses and Introduction of Technologies New to Biology  
**Institution:** Oregon State University  
**Presenter:** Barbara Taylor  
**Email:** taylorb@science.oregonstate.edu  
**Co-Presenter:** Dee R. Denver, Oregon State University  
Christine E. Schnitzler, Oregon State University  
Andrew Woodall, Oregon State University  
**Field of Interest within Biology:** Bioinformatics  

**Goals & Intended Outcome:** Oregon State University was one of twelve institutions to launch a Phage Genomics laboratory as part of the inaugural National Genomic Research Initiative of the Howard Hughes Medical Institute/Science Education Alliance. The goal of the NGRI is to provide an authentic research experience for freshman and sophomore undergraduates and the lead scientist on this NGRI project was Dr. Graham Hatfull (University of Pittsburgh). We implemented the Phage Genomics laboratory (PGL) as one of two Honors laboratory sections for a very large, year-long Introductory Biology course, Principles of Biology BI 211-213, targeting both Honors and at-risk freshmen and sophomores.

**Methods & Strategies:** Participating students were immersed into a research project to identify mycobacteriophage from the environment capable of infecting Mycobacterium smegmatis. Each student isolated, purified and characterized a different mycobacteriophage. In the fall term, genomic DNA from one mycobacteriophage, Colbert, was selected for sequencing and the students completed the annotation of the genome in the Spring term.

**Evaluation Methods & Results:** To compare data from all twelve institutions, our students were evaluated along with a comparator group by filling out two different pre- and post-surveys. One survey, the CURE, developed by Dr. David Lopatto (Grinnell College) was designed to evaluate student attitudes towards science and the second survey, developed by participating faculty in the NGRI, was a diagnostic tool to determine student knowledge of biological concepts. Our students completed these surveys on-line and the data was collected by Systemic Research, Inc (Dr. Jason Kim and Ms Linda Crasco) for analysis by Dr. Lopatto. At OSU, the PGL students performed better on their lecture mid-term and final examinations compared to the class as a whole.

**Dissemination Activities & Plans to Disseminate:** The students in this class generated valuable resources for the field because all phage isolated by the class, along with their genomic DNA, were archived at HHMI and recently the final annotated Colbert genome was submitted to GenBank (GQ303259). To close out the year, each student chose to participate in one of four different task force teams. Two teams developed communication tools: a web site (Team Communication), which when completed is housed on the OSU Biology Web Page and a poster (Team Poster), which will be posted on campus. Team Wet Lab tested other sites for the presence of mycobacteriophage and Team Genome prepared and ran another mycobacteriophage genome for Illumina IG sequencing.
Impacts of Project or Anticipated Impact: The immediate impact of the laboratory experience was on our students. They developed independence, initiative and confidence in their skills; half of them have entered research laboratories on campus to continue their research experiences. We also anticipate that elements of this laboratory will be adapted for use in all sections of the Principles of Biology course as well as other stand-alone laboratory offerings for more advanced undergraduates.

Challenges: In implementing this laboratory, we had material support and training from the HHMI/SEA as well as the laboratory of the lead scientist, Dr. Graham Hatfull. We had only small technical challenges associated with the laboratory and feel that this first year was a rousing success.

Poster #95
Category: A4
Primary Project or Approach: Student Research introduced as an Integral Part of Traditional Courses and Introduction of Technologies New to Biology
Institution: Queensborough Community College
Presenter: Patricia Schneider
Email: pschneider@qcc.cuny.edu
Co-Presenter: Raji Subramaniam, Queensborough Community College
Regina Sullivan, Queensborough Community College
Field of Interest within Biology: Microbiology, Virology

Goals & Intended Outcome: The goal is to provide every biology student with an inquiry-based, active learning experience that culminates in a faculty-mentored research project.

Methods & Strategies: Students are inspired and prepared to complete meaningful research projects by a carefully designed scaffold of inquiry and problem based experiences. Key elements of this strategy are the redesign of General biology, Enrichment Workshops and 4 new courses: 2 research-based, a colloquium and introductory biology.

Evaluation Methods & Results: The evaluation plan includes: Biology Concepts Inventory (BCI), Test of Integrated Process Skills (TIPS), Student Assessment of Learning Gains (SLAG), Survey of Undergraduate Research Experiences (SURE), student surveys, final grades, enrollment in in key courses, research presentations and the number of transfers to senior college programs. Over the past three years, the number of students engaged in biological research has increased from 21 to 47 per year.

Dissemination Activities & Plans to Disseminate: The project has been disseminated through presentations at professional meetings: Project Kaleidoscope Summer Institute, Metropolitan Association of College and University Biologists Conference, and the Annual City University of New York Conference on Science and Technology.

Impacts of Project or Anticipated Impact: Key elements of the project are being incorporated into the newly formed STEM Academy as cornerstone (General Biology) and Capstone (research projects) experiences. Ripple effects of the project include two NSF awards: REU grant for undergraduate research in the Physics Department and an STEM grant for student research in Chemistry & Biology.

Challenges: Despite evidence to the contrary, some faculty maintain that Community College students are not capable of conducting research. These individuals believe that the Department should stick to the basics.

Abstract: Scaffolding Learning Experiences to Enhance Student Research
Queensborough Community College is an open-admission minority institution that enrolls more than 11,000 degree students (29.1% black and 21.6% Hispanic). The majority are low-income, first generation students who come from educationally disadvantaged backgrounds. Engaging these students in authentic research has become an increasing important component of biology education at the College. Students are inspired and prepared to complete meaningful research projects by a carefully designed scaffold of inquiry and problem-based experiences. General Biology lab facilities were updated with networked digital microscopes and computer-based sensors to support a revised curriculum emphasizing inquiry-based exercises with written reports. During Enrichment Workshops, General Biology students work in groups on challenging problems that build content knowledge and cognitive skills. They also attend research seminars by visiting scientists. Workshop students outperform non-Workshop students in combined % A, B, C and mean final grades. Two course-based research options are available to students. Introduction to Biological Research is an integrated lecture/lab course that trains students to read primary literature as well as design and conduct research projects in molecular or cell biology.

The Research Laboratory Internship places students in cutting-edge research labs on a senior college campus. Both courses require research reports and offer the opportunity to give presentations. Newly approved courses include the Biology Colloquium in which students will read primary literature in preparation for talks by guest researchers, and Introduction to Biology for Science Majors, designed to develop the science process skills of entering students. NIH or NSF funded faculty-mentored research is a capstone experience for many students. The campus Research Coordinator serves as the key contact for information on all student research opportunities. Since 2006, the number of students engaged in biological research has increased from 21 to 47 per year. This research has resulted in the publication of several papers co-authored by students as well as awards at regional and national conferences.

Poster #96
Category: A4
Primary Project or Approach: Student Research introduced as an Integral Part of Traditional Courses and Introduction of Technologies New to Biology
Institution: Rensselaer Polytechnic Institute
Presenter: George Plopper
Email: ploppg@rpi.edu
Field of Interest within Biology: Cell Biology

Goals & Intended Outcome: GOAL: Have students critique scientific research using formal logic to identify scientific hypotheses. Outcomes: students will (1) translate scientific jargon into everyday language, (2) identify hypotheses, premises, and conclusions in a scientific study, and (3) evaluate arguments supporting the hypotheses.

Methods & Strategies: A series of in-class exercises are used to translate the jargon of research articles, define hypotheses, learn the structure of a formal argument, and find the premises and conclusions in a research article or project. This is then applied to the students' own research projects taking place during the semester.

Evaluation Methods & Results: EVALUATION METHODS Type I: written, based on research articles: (1)translations of jargon into common language, (2)translated hypotheses, (3)formal arguments students feel would best support the hypotheses, (4)lists of premises and corresponding conclusions, and (5)comparisons of student-expected arguments with those contained in research articles. Type II: written, as a research proposal and final report, containing hypotheses and logical arguments; and
verbal, as a poster presentation. RESULTS Types I and II: Students have little trouble translating hypotheses, but more difficulty identifying formal arguments.

**Dissemination Activities & Plans to Disseminate:** This method will be presented as part of the ancillary materials for a new textbook, "Principles of Cell Biology," written by George Plopper and published by Jones and Bartlett Publishers (expected release, April 2010). The results will be submitted for publication in a peer-reviewed journal in 2010.

**Impacts of Project or Anticipated Impact:** The data collected to date suggest that more effort must be made to help students uncover the thought process that underlies scientific research. Students are very results-oriented and have little interest in the underlying logic that drives hypothesis-driven research. They also have trouble discriminating between a scientific hypothesis and a simple prediction. We will be placing more emphasis on this method in our courses in the 2009-2010 academic year.

**Challenges:** The most significant challenge we encountered is the subjective nature of translating jargon into common language. This made formal grading difficult and caused more concern and confusion in our students than we expected. Also, many students found little relevance in the exercises to their understanding of how science is conducted, and this dampened their enthusiasm and participation. Making a formal argument exciting to first year college students is more difficult than we expected.

**Poster #97**

**Category:** A4

**Primary Project or Approach:** Student Research introduced as an Integral Part of Traditional Courses and Introduction of Technologies New to Biology

**Institution:** Southwestern University

**Presenter:** Romi Burks

**Email:** burksr@southwestern.edu

**Co-Presenter:** Matthew M. Chumchal, Texas Christian University

**Field of Interest within Biology:** Undergraduate Research

**Goals & Intended Outcome:** Our goals include: 1) emphasizing value of publishing with undergraduates; 2) developing a rubric for ascertaining when such publishing represents a reasonable goal; 3) identifying unique challenges that accompanying writing with undergraduates; and 4) brainstorming strategies for overcoming those challenges.

**Methods & Strategies:** We base our paper on our personal experience and success of publishing with students. We provide a top ten list of reasons to publish with undergraduates, a flow chart that helps decide when to publish with undergraduates and how to assign authorship and a table of key points to recall when writing with students.

**Evaluation Methods & Results:** Our work constitutes more of a "case study" approach. Burks currently has five publications with student co-authors and four manuscripts in process. Chumchal currently has several manuscripts in process.

**Dissemination Activities & Plans to Disseminate:** Beginning elements of this poster appeared in a talk at the 2008 ESA meeting. The content of this poster currently appears in a draft manuscript that we plan to submit to a pedagogical journal, perhaps Academic Exchange Quarterly although we are still in the process of finding a suitable outlet.
Impacts of Project or Anticipated Impact: We hope that our collective thoughts will encourage faculty at PUIs that want their work to have even more impact to think about publishing with undergraduates and giving them the responsibility of authorship in some form. In addition, we hope that producing an article that defines and discusses the issues and challenges up front will help lessen the unknown factor that goes into decisions about publishing with undergraduates.

Challenges: Authorship issues can be more problematic for PUI faculty: short residence time of students; 2) integrating the work of multiple students; 3) less experienced writing ability of undergraduates; and 4) of course, actual writing time. The time to negotiate issues about authorship and writing with undergraduates starts on Day 1. With the student, explain what it takes to accumulate enough data for publication and begin teaching students how to develop their story. When the time comes to write or respond to reviews, schedule a face-to-face weekend writing retreat and ask for modest support from your institution.

Abstract: Who’s on First? How to write, publish and negotiate issues of authorship with undergraduate students

Scholarship expectations at many primarily undergraduate institutions (PUIs) often do not include publishing in peer-reviewed journals. Yet, most faculty members arrive at PUIs from graduate or postdoctoral institutions with substantial training in research and publication. Although no substitute exists for excellence in teaching, publications need not cease with the move to a PUI. The substantial time investment required to teach students to conduct research and write may be perceived as a barrier to publication by faculty at PUIs whose primary responsibility is teaching.

Four main challenges face ecologists wishing to publish at PUIs: 1) the short residence time of students; 2) multiple student projects contributing to a single publication; 3) the insufficient writing skills of most undergraduates relative to the standard for publication in scientific journals; and 4) the substantial time investment required to write and revise manuscripts. In this paper we offer general strategies on publishing with undergraduates that help overcome the aforementioned challenges. Taking a cue from Weltzin et al. (2006), we also examine how authorship issues likely play out at PUI institutions and offer advice for faculty on how to determine authorship rights and order, thereby answering the proverbial question “Who’s on first?”

Poster #98
Category: A4
Primary Project or Approach: Student Research introduced as an Integral Part of Traditional Courses and Introduction of Technologies New to Biology
Institution: The University of La Verne
Presenter: Christine Broussard
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Field of Interest within Biology: Cell Biology

Goals & Intended Outcome: The goal is to adapt modern research techniques of cell and developmental biology to laboratory courses, to incorporate exemplary pedagogical practices, and to provide genuine research experiences to undergraduates. The intended outcome is to increase the preparedness of underrepresented students in STEM and the probability that they will pursue STEM careers.

Methods & Strategies: By adapting the research techniques of fluorescence microscopy, stereomicroscopy, digital imaging, microsurgery, and microinjection into new, innovative, inquiry-based undergraduate laboratory experiences, we will provide students with a real-world view of science and a genuine experience with the process of modern biology.
**Evaluation Methods & Results:** Undergraduate collaboration on the development and adaptation of inquiry-based laboratory protocols will ensure the inclusion of student perspective from design to implementation. Student performance and impact feedback will also be collected by observation of undergraduates conducting laboratory experiments and research projects, formal student reports, focus-group interviews, and pre-, mid-, and post-course questionnaires to assess student learning and skills development. Time for senior project completion, STEM career choices, and recruitment and retention of majors will be tracked to evaluate the project’s impact.

**Dissemination Activities & Plans to Disseminate:** The PI has attended the 2008 CCLI Conference and AAC&U’s Engaging Science, Enhancing Learning and presented preliminary findings. The PI and an assessment collaborator published a manuscript in CBE-Life Sciences Education spring 2008. Another manuscript is planned and PI is presenting a poster at 2009 CCLI conference.

**Impacts of Project or Anticipated Impact:** On time senior project completion rates and percentage of students applying for and being accepted into graduate and professional schools have improved for majors. Preliminary data collected in 2003 indicated only 25-30% of biology majors completed undergraduate requirements for graduation within four years. By 2007, 50% of biology majors had achieved on time completion. In 2008, 70% had on time completion. Furthermore, in 2008 more than 50% of biology majors had applied and been accepted into professional or doctoral graduate programs.

**Challenges:** It was recognized that on time completion and STEM career issues were the result of systemic problems in the curriculum. This proposal addresses one problem, the issue of modernization of the curriculum and innovation of pedagogical practices. Other problems stemmed from a lack of a cohesive framework for developing the skills and talents of our diverse student body. An effective cohesive framework has arisen out of this NSF-funded effort and the department’s efforts to redesign the biology curriculum, including community building (lab meetings, peer groups), formal instruction in research methods and biostatistics, formal opportunities to present student work (senior symposium), and STEM professional development for students.

**Poster #99**  
**Category:** A4  
**Primary Project or Approach:** Student Research introduced as an Integral Part of Traditional Courses and Introduction of Technologies New to Biology  
**Institution:** Troy University  
**Presenter:** Christi Magrath  
**Email:** cmagrath@troy.edu  
**Co-Presenter:** Yoon Cho, Troy University  
**Field of Interest within Biology:** Molecular Biology & Biochemistry  

**Goals & Intended Outcome:** Challenging students to develop skills in written inquiry is a vital part of science education. In lower level biology courses, students can be challenged to develop questions and engage in student centered dialog; more advanced students can develop questions.

**Methods & Strategies:** One approach for engaging students in written inquiry is the use of student-led online discussion. Another approach for advanced students is use of grant writing to engage students in developing a question and discovering approaches that can be utilized.

**Evaluation Methods & Results:** To evaluate the impact of student-led inquiry and discussion on student learning, "Principles of Biology" students and faculty at Troy University participated in controlled (faculty-led) and open (student-led) online discussions.
**Poster #100**

**Category:** A4  
**Primary Project or Approach:** Student Research introduced as an Integral Part of Traditional Courses and Introduction of Technologies New to Biology  
**Institution:** U. North Carolina at Chapel Hill  
**Presenter:** Patricia Pukkila  
**Email:** pukkila@unc.edu  
**Co-Presenter:** Martha Arnold, U. North Carolina at Chapel Hill  
**Field of Interest within Biology:** Genetics

**Goals & Intended Outcome:** Our primary goal is to increase the number of science courses at UNC-Chapel Hill that include original student inquiry and research. In addition, we want faculty to evaluate students’ abilities to identify important questions, understand appropriate modes of inquiry, demonstrate research skills, and communicate their results to others.

**Methods & Strategies:** Our methods are to support faculty who redesign their courses to include a research component by paying a graduate student chosen by the faculty to be a Graduate Research Consultant (GRC) for 30 hours of work during the semester. The duties of this GRC are to “coach” the undergrads on the research component, including communicating findings to the entire class.

**Evaluation Methods & Results:** Ongoing evaluation of the GRC program draws on both quantitative and qualitative measures, and is conducted in collaboration with our Office of Institutional Review and Assessment. In addition to surveys and focus groups, the OUR has developed and implemented a rubric to evaluate faculty commitment to incorporate research components and evaluate learning outcomes. To date, 52 science courses in 9 departments have been taught using GRCs (24% of all GRC courses). Overall, 96% of faculty report that they will use the GRC model again. Over 80% of faculty report that the program is “significant” or “transformative” for the student learning outcomes described in #2.

**Dissemination Activities & Plans to Disseminate:** We have disseminated information about the GRC Program on campus through a discussion forum (The Place of Inquiry in the Undergraduate Classroom) and nationally with presentations at conferences and publications. Links to the publications are available at http://www.unc.edu/depts/our/resources.html.

**Impacts of Project or Anticipated Impact:** Since its inception in 2003, the GRC model has been used in 217 courses enrolling nearly 7,000 students. The program continues to grow exponentially as faculty recruit other faculty, and GRCs recruit other GRCs. Faculty, GRC and undergraduate surveys and interviews reveal benefits for undergraduates (improved reasoning, increasing the complexity and
creativity in what students attempt, reducing student anxiety), for graduate students (gaining confidence and experience, seeing the “inner workings” of courses) and for faculty (using GRCs from other disciplines to provide “insider perspective”, being energized by the student projects, redesigning old courses).

**Challenges:** Currently students pre-register for courses without knowing if they will be taught as GRC courses. We publish lists of GRC courses taught in previous semesters, but we hope to address this issue with the new course catalogue system (to be implemented in 2010) which will include information about what students will actually do in particular courses.

**Poster #101**
**Category:** A4
**Primary Project or Approach:** Student Research introduced as an Integral Part of Traditional Courses and Introduction of Technologies New to Biology
**Institution:** UNC at Greensboro
**Presenter:** Mary Crowe
**Email:** mlcrowe@uncg.edu
**Field of Interest within Biology:** Quantitative Biology

**Goals & Intended Outcome:** Mathematical and Biology coursework and student research at the University of North Carolina at Greensboro generally has been conducted separately with little interaction. The primary goal of our NSF MathBio program was to bridge this gap by providing integrated undergraduate research in biology and mathematics for capable undergraduate students. However, we also created a new interdisciplinary course for upper division students.

**Methods & Strategies:** The primary strategy is for mathematics and biology students to work on a team, co-mentored by both a mathematics and biology faculty member. In terms of the new interdisciplinary course, faculty members team-teach the topics.

**Evaluation Methods & Results:** The undergraduate students have become co-authors on 14 peer-reviewed papers and have given more than 50 presentations of their work at regional, national and international conferences. We know that students self-report intellectual gains as a result of being involved in an undergraduate research project. Using a field tested rubric, we are independently assessing student skills pre and post research experience to verify student intellectual gains related to written skills, critical thinking and integration of knowledge.

**Dissemination Activities & Plans to Disseminate:** We are presenting the results of our program at conferences, in journal articles and on our website.

**Impacts of Project or Anticipated Impact:** All of the participants in our program who have graduated are pursuing graduate study in biology or mathematics related fields. We have doubled the number of faculty members interested in mentoring students on interdisciplinary quantitative biology research projects. We have offered the interdisciplinary course once and are in the process of having the course become a regular offering for upper division students.

**Challenges:** The languages of mathematics and biology are different and the faculty mentors hail from a variety of international backgrounds which has added new meaning to language barriers. Regular face to face meetings, humor, and food have appeared to help smooth any problems. The recent economic downturn has significantly impacted the extent of curricular changes we will be able to implement.
Poster #102
Category: A4

**Primary Project or Approach:** Student Research introduced as an Integral Part of Traditional Courses and Introduction of Technologies New to Biology

**Institution:** University of Maine

**Presenter:** Mary Tyler

**Email:** mary.tyler@umit.maine.edu

**Co-Presenter:** Ryan Cowan, University of Maine
Farahad Dastoor, University of Maine
Brian Olsen, University of Maine

**Field of Interest within Biology:** General Biology

**Goals & Intended Outcome:** We are revising our large introductory biology courses by introducing inquiry-based learning into the laboratory and creating multimedia materials to augment lecture. The major goal of this project is to increase science literacy and enthusiasm for science among our students, to improve student retention, and to use multimedia technology to increase the effectiveness of learning.

**Methods & Strategies:** We have designed inquiry-based labs in which students are asked to formulate questions, investigate background information, design experiments with controls, record data, analyze their data, and draw conclusions. For this we are writing a lab manual and teacher’s guide. For lecture, we are creating animated movies that are based on the Campbell biology textbook.

**Evaluation Methods & Results:** In the first year, we introduced the inquiry-based labs into 2 sections of our 800-student course, in the second year into 15 lab sections, and next fall into all 45 sections. We have collected data on performance in lecture and attitudes towards science. Our data indicate that inquiry-based labs increase students’ appreciation and attitudes towards science, and that effective TA training is the most important factor in determining success of the inquiry-based method in lab. For lecture videos, only data from student evaluation surveys have yet been collected so far, with the result that students find the movies to be valuable for studying, making complex lecture material clear and easy to understand.

**Dissemination Activities & Plans to Disseminate:** Our lab manual and teacher’s guide, covering material for the first semester course, will be published by W. H. Freeman in 2010. Material for the second semester course will be published the following year. Our lecture movies are being disseminated to our students through Synapse, an in-house course management application developed by the BioMediaLab at UMaine.

**Impacts of Project or Anticipated Impact:** We expect to improve education in our introductory biology courses, which serve over 50 different majors at UMaine. Of the over 800 students served each year, approximately 700 are first-year students. We expect to have a major effect on the retention of these students, as well as improving learning. By implementing inquiry-based labs, we will also be lowering the cost of delivering labs over that of teaching the previous traditional labs. By publishing our inquiry-based labs, we expect to reach a wider audience, while providing teachers with the means of making inquiry-based instruction a success through our teacher’s guide.

**Challenges:** Numerous studies have shown that inquiry-based learning in lab is superior to traditional cookbook methods, however it is not a guarantee that inquiry-based methods will be highly successful. The open-ended aspects can cause frustration for teaching assistants and students. When students’ questions are turned back into a question for the student, students may feel their teachers are not being helpful. The most important element in determining success, therefore, is proper train-
ing of the teaching assistants, so they have had practice in the inquiry-method and fully understand its goals before they start teaching. We are therefore designing a training workshop for our TAs prior to the start of the semester, as well as a fall course on teaching methods.

Poster #103
Category: A4
Primary Project or Approach: Student Research introduced as an Integral Part of Traditional Courses and Introduction of Technologies New to Biology
Institution: University of Texas at El Paso
Presenter: Stephen Aley
Email: saley@utep.edu
Co-Presenter: Ann Darnell, Rosa Maldonado, and Kristina Garza
Field of Interest within Biology: Molecular Biology & Biochemistry

Goals & Intended Outcome: This project is intended to encourage more undergraduate students to continue into graduate programs in Biomedical Research. Our immediate goals are to instill a positive attitude of students about scientific research, foster an interest in research careers, and improve critical thinking skills.

Methods & Strategies: Building on findings by us and others that working as an undergraduate member of a research laboratory can foster all of our target goals, we have instituted a mandatory research experience in two core Biology/Microbiology classes, involving up to 400 students per year.

Evaluation Methods & Results: Our evaluation methods triangulate through quantitative data from the student information system, surveys/phone interviews soliciting student opinions to measure change in perception, and incorporate a Logic Model to direct the overall evaluation plan. Number of students enrolled in modified courses (including failure/withdrawal rates), retention and graduation will be presented. Survey results showing effects of modified undergraduate research experiences will also be included. The goal of increasing matriculation to MS/PhD programs for underserved students will be highlighted throughout the poster.

Dissemination Activities & Plans to Disseminate: Both general and specific activities from this initiative have been reported by Faculty and Students at local and national meetings. As more data become available and are analyzed, we anticipate publishing project results.

Impacts of Project or Anticipated Impact: Three major impacts have been initially identified for further study. First, enrollment in the modified research labs is increasing. Second, more students are graduating in Biology and Microbiology each year, and third, a number of students indicate a change in career plans after graduation. Among students responding to a survey and/or brief email, many state that the semester-long research experiences impacted them in their future career plans and even those not changing their minds felt the research experience clarified their decision regarding their future education/career plans.

Challenges: Tracking students after they leave the institution is challenging, requiring that we know when students are graduating/leaving and maintaining updated email addresses or phone numbers. Other methods for locating students might include social networking. The second challenge is leveraging financial resources in order to provide the necessary long term support for the student research laboratories. Support from the University Development Office and a request for "used equipment" from Faculty and research center laboratories receiving new equipment are two sources assisting with solving this challenge.
Poster #104
Category: A4
Primary Project or Approach: Student Research introduced as an Integral Part of Traditional Courses and Introduction of Technologies New to Biology
Institution: University of Wisconsin
Presenter: Jean Heitz
Email: jgheitz@wisc.edu
Field of Interest within Biology: General Biology

Goals & Intended Outcome: Many studies indicate the importance of involving undergraduates in mentored research. In introductory biology we partner with researchers to engage our students in real research experiences. Writing assignments insure our student know what they are doing, why they are doing it and what the results mean.

Methods & Strategies: In a few words, we provide encouragement and support. The first semester we provide guidance on how to contact mentors, develop a resume and respond during an interview. As students conduct their research, we teach them how to critically analyze literature and to write to communicate their understanding.

Evaluation Methods & Results: To evaluate our program we conducted a brief review of the literature. In particular we concentrated on studies which surveyed faculty and students regarding the benefits of undergraduate research. Using these we noted what others found to be key learning goals, advantages, benefits and limitations of these programs. We then surveyed past mentors and students using many of these same parameters and compared our results to those from the literature. We also interviewed a number of mentors and held a panel discussion of former students. Both types of interviews were videotaped.

Dissemination Activities & Plans to Disseminate: We presented the results of our study at a Teaching and Learning Symposium on the UW Campus during the summer of 2008. In the spring of 2009, we presented a poster on the results at a Biology Leadership Conference sponsored by Pearson Publishing. We are in the process of writing a short article for publication.

Impacts of Project or Anticipated Impact: In a 2005 survey of former mentored research students, 54 reported they averaged an additional 2 semesters of research in the same or a different lab on campus. Students (100) without this experience averaged only 0.65 semesters total. In our 2008 survey of 20 additional mentored research students, we found similar results. In fact, about 40% of these students indicated they spent an additional 3 or 4 semesters doing research. In other words, not only does this experience put a large number of students into research labs, but it also increases the likelihood they will continue doing research.

Challenges: We began this program in 1983 and have been very grateful for all of the researchers who have supported our students over the years. One unexpected challenge early on had to do with our insistence that students be able to write a journal style article describing their research. Some faculty felt that this requirement took time away from the students’ in-lab time. However, as they realized writing was a very effective way to make sure students really understand what they were doing this changed. Our only other major challenges have to do with logistics involved with the success and growth of the program.

Abstract: What do undergraduates gain from mentored research experiences? What are the values of engaging undergraduates in independent research early in their college careers? How does this experience affect the students' views of science, the university in general and
their future goals?

Many studies indicate the importance of involving undergraduates in mentored research early in their careers. In our introductory biology sequence, we partner with researchers on campus to engage our students in real research experiences. In our course, staged writing assignments are designed to insure our student know what they are doing, why they are doing it and what the results mean.

In this poster I describe: 1) the mechanisms we use in Introductory Biology 151-152 to place more than 350 highly diverse freshmen and sophomores each year into mentored research and 2) the value of the experience from the instructors', mentors' and students' perspectives. The poster and web site (http://tinyurl.com/UndergradResearch) also include information on the types of preparation necessary to help insure student success in mentored research and the types of writing assignments and periodic review needed to help insure student understanding.

**Poster #105**  
**Category:** A4  
**Primary Project or Approach:** Student Research introduced as an Integral Part of Traditional Courses and Introduction of Technologies New to Biology  
**Institution:** USDA-ARS Center for Medical, Agricultural, and Veterinary Entomology  
**Presenter:** Richard Mankin  
**Email:** Richard.Mankin@ars.usda.gov  
**Field of Interest within Biology:** Biophysics

**Goals & Intended Outcome:** Students will develop improved understanding of the research process and how information derived from the research is disseminated. If feasible, a short paper ultimately will be produced from the results of a small research project.

**Methods & Strategies:** Student is provided an open ended project that can be completed within an 8-week internship period at a research laboratory with high-level facilities and technical assistance. A 10-min seminar on the results of the project is presented to scientists at the end of the project.

**Evaluation Methods & Results:** The student's experimental procedures and observations during the project are provided ongoing evaluation by experienced researchers. Literature and suggestions for self-directed literature searches are provided at relevant points as the research proceeds. The student produces a skeleton of a research manuscript that is edited by the mentor.

**Dissemination Activities & Plans to Disseminate:** Seven students have completed internship projects and three journal articles were developed from successful efforts.

**Impacts of Project or Anticipated Impact:** All but one of seven students enjoyed their projects, but three decided against continuing on a career in science. One student went to graduate school, and three others moved into technical or extension positions.

**Challenges:** The choice of research problem is a very important factor. The problem must seem relevant to the student and the research must be completed during the internship period. Unanticipated problems developed in three projects that would have precluded successful completion, and the projects were significantly altered to accommodate the intern's skills and interests.
Poster #106
Category: A4

Primary Project or Approach: Student Research introduced as an Integral Part of Traditional Courses and Introduction of Technologies New to Biology
Institution: Utah Valley University
Presenter: Ruhul Kuddus
Email: kuddusru@uvu.edu
Field of Interest within Biology: Molecular Biology & Biochemistry

Goals & Intended Outcome: To investigate undergraduate research and research training outcomes among individual researchers and small groups and developing a lab manual for the students to follow.

Methods & Strategies: Gave nearly identical research problems to individual student researchers and small groups of researchers and assess research accomplishments and actual learning.

Evaluation Methods & Results: Learning was assessed by student’s ability to conduct and record experiments and draw conclusions. Student success was assessed by student’s ability to present data at conferences.

Dissemination Activities & Plans to Disseminate: The observation was presented at the American Society for Microbiology Conference for Undergraduate Educators (ASMCUE 2009). I am planning to write a short article on the observation to be published in a journal.

Impacts of Project or Anticipated Impact: My finding (that individuals accomplish more than groups in laboratory research projects) apparently contradicted the popular view that groups learn better than individuals. My abstract drew relatively smaller audience at ASMCUE (2009), although a few enthusiastically supported my observations. My data set is not very big so I was not too forceful. I believe the data is valid and it indicates the difference between classroom learning and laboratory bench learning. The finding, I believe, will impact educators who conducts research training.

Challenges: Failing to complete experiments in anticipated time period was the unexpected challenge (unexpected because I thought I planned everything adequately). I invested more times in preparations to face the issue.

Abstract: Groups versus individuals: Who accomplished more in undergraduate research and research training activities?

Background: Analysis at the molecular level is becoming increasingly important in the field of biology. Molecular biotechnology research and research training may offer a broad-based foundation to students majoring in biology. Research design: During the past five years, I tested learning effect of a simple biotechnology project- cloning and expression of a human gene in bacteria and purification and characterization of the protein; given to individuals taking a one-semester research course or small groups taking laboratory section of a molecular biology course. Each student received a laboratory manual crafted to support the student research project. Learning was assessed by student’s ability to conduct/record experiments and draw conclusions. Student success was assessed by student’s ability to present data at conferences. Results: Six individuals and two groups (4-5 students) took the project.
Almost all individuals continued the project for one or more extra semesters to obtain presentable data. All students PCR-cloned the genes, four individuals and the groups transformed and screened bacteria, two individuals optimized gene expression and one individual purified and characterized one protein. Two individuals presented multiple posters in regional conferences. Four individuals preferred working on fixed hours of a given day of the week (fixed schedule) and sought experience rather than project outcome. All individuals developed significant confidence in laboratory works. The project outcomes were not sufficient for publication. Time limitation and limited literature search were the major constraints. In general, group projects were less productive than individual projects and flexible schedule was more productive than fixed schedule. Conclusions: Individual undergraduate research project in molecular biotechnology is generally beneficial to biology majors but time constraint limits the output even for highly defined projects. A collaborative approach could be a suitable alternative.

Poster #107
Category: A4
**Primary Project or Approach:** Student Research introduced as an Integral Part of Traditional Courses and Introduction of Technologies New to Biology
**Institution:** Virginia Tech
**Presenter:** Deborah Johnson
**Email:** dejohns4@vt.edu
**Co-Presenter:** Erin Dolan, Virginia Tech
**Field of Interest within Biology:** Biology Education

**Goals & Intended Outcome:** To identify and evaluate the outcomes and impacts of Undergraduate Research Experiences (UREs) conducted at Research Universities on both the participating undergraduate student and their graduate student or postdoctoral mentor. Initial focus has been on the benefits and challenges faced by the postgraduate mentor.

**Methods & Strategies:** A qualitative approach is used to obtain detailed information on the mentor-protégé relationships that develop during undergraduate research experiences. Data is predominantly derived from answers to in-depth interviews which are transcribed and analyzed using a constant comparative method.

**Evaluation Methods & Results:** Undergraduates and postgraduate students were interviewed after completing their URE-related experience in person or by phone using semi-structured interview protocol. We actively sought reports of both positive and negative outcomes. A constant comparative method of data analysis was used to construct categories representative of recurring patterns in the mentors’ responses. Postgraduate mentors reported twice as many gains as challenges, neither of which were limited by their motives for mentoring. Results have been published in J Sci Educ Technol.

**Dissemination Activities & Plans to Disseminate:** We have presented our work at the 2007 and 2008 annual conferences of the National Association of Research in Science Teaching. We have published in the Journal of Science Education and Technology (May 2009) and have submitted (June 2009) our second manuscript to the International Journal of Science Education.

**Impacts of Project or Anticipated Impact:** We anticipate our work will be of general interest to researchers mentoring URE students and to the science education community seeking to provide undergraduate and graduate students with more opportunities for active learning/teaching experiences. We propose that understanding the extent to which UREs impact the educational training of postgraduate mentors may uncover new ideas of how to maximize the educational benefits that can accrue from the resources dedicated to promoting undergraduate research experiences.
Challenges: We encountered no significant, unexpected challenges. Working with participants from only one lab group made it relatively easy to track past and present members and invite them to participate in this study. Although a larger participation rate was desired, the actual number of people that agreed to participate was expected. I do however anticipate more challenges as we seek funding for a large, nation-wide study using this exploratory case as the groundwork.

Abstract: Toward a Holistic View of Undergraduate Research Experiences: Exploring the Impact on Postgraduate Mentors at Research Universities

A growing body of research documents the positive outcomes of research experiences for undergraduates. Many of these findings originate from the study of undergraduate research experiences (UREs) at predominantly undergraduate institutions. Individuals at research universities have noted the impracticality of one-on-one mentoring of undergraduates by faculty because of insufficient numbers of faculty and competing demands for their time. Thus, postgraduates (i.e., graduate students and postdoctoral researchers) regularly assume a primary role in mentoring undergraduates in research. The Boyer Commission recognized that graduate students are directly involved in the education of many undergraduates at research universities. Yet, the ways in which undergraduates and postgraduates influence each other’s training has been largely unexamined.

Here we present findings from a case study that identifies the gains and challenges reported by postgraduate students who mentored undergraduates in research. Postgraduate mentors reported twice as many gains as challenges, neither of which were limited by their motives for mentoring. We also present postgraduate mentors’ perspective on how the overall presence of undergraduate researchers affected their lab community as a whole.

We propose that understanding the extent to which UREs impact the educational training of postgraduate mentors may uncover new ideas of how to maximize the educational benefits that can accrue from the resources dedicated to promoting undergraduate research experiences.

Poster #108
Category: A4
Primary Project or Approach: Student Research introduced as an Integral Part of Traditional Courses and Introduction of Technologies New to Biology
Institution: William Woods University
Presenter: Mary Spratt
Email: mspratt@williamwoods.edu
Co-Presenter: Gary Kulick, Loyola Marymount Univeristy
David Lopatto, Grinnell College
Sarah C.R. Elgin, Wilson Leung, and Chris Shaffer, Washington University, St. Louis
Stuart Ketcham, University of the Virgin Islands
Field of Interest within Biology: Genomics/Bioinformatics

Goals & Intended Outcome: The Genomics Education Partnership (GEP) seeks both to provide quality research experiences for students through novel, publishable genomics research, and to provide the scientific community with the needed human input for bringing raw sequence data to usable form through both sequence improvement and annotation.

Methods & Strategies: The GEP consortium of over sixty colleges and universities is centered at Washington University--St. Louis. Faculty and student T.A’s gather there for training. Currently, the collaborative, distributive effort centers on sequence improvement and annotation of the dot chromosomes of several Drosophila species.
Evaluation Methods & Results: Post-class surveys of students from participating schools indicate learning gains similar to those of students participating in full-time summer research projects, using the Likert Scale. [Lopatto et al., (2008) “Genomics Education Partnership”, Science 322:684-5.] Surveys of learning gains are being modified and academic evaluations developed. Pre- and post-tests using comparable student groups were used during the 2008-2009 academic year, and are currently being evaluated. Participating faculty meet each summer to discuss the past year's experiences, and to modify and add to existing curricula and evaluation methods.

Dissemination Activities & Plans to Disseminate: Presentations on the GEP are being given at both scientific and educational meetings. Publications to date include the journal Science (cited above) and by Slawson et al. in Genome Biology. Other publications are in progress. We invite other schools to join the GEP. (Contact selgin@biology.wustl.edu)

Impacts of Project or Anticipated Impact: Currently, classes of students at over 60 colleges and universities have been able to participate in cutting-edge scientific research. Student comments show that they are excited about their ability to participate in this level of research. Indications are that this type of research involving an entire class is cost-effective in terms of personnel, money, and other resources. Novel contributions are being made to the genome sequencing effort. We believe this effort favorably impacts methods of undergraduate education and science databases.

Challenges: 1) Since many classes at small schools can only be offered every other year, students trained one year may graduate before they can serve as a TA for the next class. The GEP will provide training for a second TA on a case-by-case basis. 2) University settings, curricular requirements, and student bodies vary greatly. We are trying to develop a modular, flexible curriculum from which faculty can pick and choose activities and formats most applicable for their situation. 3) Schools are scattered across large distances posing communication challenges. A WIKI inviting both faculty and student input, web site, and group meetings help.

Abstract: The Genomics Education Partnership (GEP; http://gep.wustl.edu/) is a consortium of faculty from over 60 current colleges and universities in a collaborative project to engage undergraduate students in genomics research based on faculty-scientist partnerships. Integration of genuine genomic research into undergraduate courses greatly expands the number of students able to experience research, enables them to understand genome sequencing and gene structure in a fundamental way, and helps students develop important transferable skills. Students appreciate that they are making novel contributions to the scientific databases, and that their work will result in a scientific publication. Advantages for the scientific community include help with the necessary labor-intensive processes of sequence finishing and annotation. Post-course surveys of student learning gains have yielded results similar to those of students involved in a full-time summer research experience (Lopatto, et. al. 2008). The first project undertaken by the GEP is sequence improvement and annotation of the dot chromosomes of several Drosophila species. This unique domain has properties of both euchromatin, including normal gene density, and heterochromatin, including a high density of repetitive DNA remnants of transposable elements and retrotransposons. Undergraduates improve the posted whole genome shotgun assembly to the mouse genome standard (close gaps, generate consensus sequence with an estimated error rate of less than 1 in 1000bp, verify assembly using restriction digests), and generate carefully annotated gene models. The pooled data is being used for analysis of the entire chromosome, including comparisons among different Drosophila species.

We have successfully implemented a flexible and modular curriculum into a variety of settings, including various types of colleges/universities, student populations, schedules, and types of courses. We find that genomics research is both rewarding for us as teachers, and for students as learners. Post-course surveys of student learning gains demonstrate results similar to those of students involved in
full-time summer research experiences (Lopatto, et. al. 2008). We welcome additional partners from the scientific and academic community to join us and to pose meaningful annotation problems for our students. Funded by HHMI and NIH.

The Genomics Education Partnership (GEP) seeks both to provide quality research experiences for students through novel, publishable genomics research, and to provide the scientific community with the needed human input for bringing raw sequence data to usable form through both sequence improvement and annotation.

The GEP consortium of over sixty colleges and universities, centered at Washington University--St. Louis. Faculty and student T.A's gather there for training. Currently, the collaborative, distributive effort centers on sequence improvement and annotation of the dot chromosomes of several Drosophila species.

Post-class surveys of students from participating schools indicate learning gains similar to those of students participating in full-time summer research projects, using the Likert Scale. [Lopatto et al., (2008) "Genomics Education Partnership," Science 322:684-5.] Surveys are being modified and academic evaluations developed


Presentations on this program are being given at both scientific and educational meetings. Publications to date include the journal Science (cited above) and by Slawson et al. in Genome Biology. Other publications are in progress. We invite other schools to join the GEP. Contact selgin@biology.wustl.edu. Currently, classes of students at over 60 colleges and universities have been able to participate in cutting-edge scientific research.

Student comments indicate that they are excited about their ability to participate in this level of research. Indications are that this type of research involving an entire class is cost-effective in terms of personnel, money, and other resources. Novel contributions are being made to the genome sequencing effort.

1) Since many classes at small schools can only be offered every other year, students trained one year may graduate before they can serve as a TA for the next class. The GEP will provide training for a second TA on a case-by-case basis.

2) University settings, curricular requirements, and student bodies vary greatly. We are trying to develop a modular, flexible curriculum from which faculty can pick and choose activities and formats most applicable for their situation. 3) Schools are scattered across large distances posing communication challenges. A WIKI inviting both faculty and student input, web site, and group meetings help.
**Presenter:** Ellen Goldey  
**Email:** goldeyes@wofford.edu  
**Field of Interest within Biology:** General Biology

**Goals & Intended Outcome:** The outcome of our project will be a new foundational course, Biological Inquiry, which will build students' skills in data collection, use of primary literature, statistical analysis, communication, critical thinking, and biological content knowledge.

**Methods & Strategies:** During Spring '09, biologists (10+) met weekly for workshops and planning. This summer, co-PIs and students are 1) evaluating data collection technologies, 2) developing protocols, assignments, and grading rubrics, 3) selecting primary literature, and 4) adapting statistical software (e.g., JMP) for student use.

**Evaluation Methods & Results:** Project level: Our four project evaluators (one intramural) met with the biology faculty and the Academic Dean in a day-long session to discuss the project and provide feedback. Course level: All Wofford students will take the nationally-vetted critical thinking and writing exam (CLA) as incoming students and again as sophomores (N = 200 each for those who take Biological Inquiry and those who do not). Students will take pre/post-semester surveys of learning gains (SALG), and faculty are developing a CLA-like mid-term exam.

**Dissemination Activities & Plans to Disseminate:** PI Goldey will be disseminating this work during a poster session and in workshops at the 2009 SENCER Summer Institute (Chicago, August 6-10). In addition, other PIs and students are enthusiastic to present our work at various regional and national conferences.

**Impacts of Project or Anticipated Impact:** The team work taking place is exciting and has transformed our department. Previously collegial but autonomous in our course work, we are now fully aware of each others' expertise, and we are sharing ideas with new enthusiasm for our discipline. The impact of our new course on the College will be significant (over half of our incoming students will take it), and we have had many formal and informal meetings with the Curriculum Committee, the full faculty, and the Dean, Registrar and advisors of first year students. Such meetings have been important for airing concerns and generating enthusiasm for such a major reform.

**Challenges:** While not unexpected, the challenge of building consensus among eleven, strong-willed PhDs is formidable. However, the final course product also benefits from such a broad base of expertise, energy, and creativity. The weekly meetings during the Spring semester were invaluable for sharing ideas and voicing concerns, and this summer the undergraduates have added their perspective, energy, and enthusiasm. We have used internal and external experts to lead workshops for the whole group, and we have all developed new skills and broadened our biology. Discussion of current issues, for example, happens on a daily basis.

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**Poster #110  
Category: A5  
Primary Project or Approach:** Other: Engaging Undergraduate Students in Research and in Professional Society activities  
**Institution:** American Physiological Society  
**Presenter:** Marsha Matyas  
**Email:** mmatyas@the-aps.org  
**Field of Interest within Biology:** Physiology & Anatomy

**Goals & Intended Outcome:** The APS Undergraduate Summer Research Fellowship (UGSRF) pro-
gram seeks to excite and encourage undergraduate (UG) students worldwide to pursue a career as a basic research scientist.

**Methods & Strategies:** The APS funds 24 students annually for a full-time summer research experience, interactive online assignments on research skills and career development, and a travel fellowship to attend Experimental Biology. As a result of the program, students: 1) Learn to develop a hypothesis-driven research project, collect and analyze data, and write up the experimental results; 2) Present at least one poster or oral presentation on their experimental results at a scientific meeting; 3) Attend a national multi-society scientific meeting and interact with fellow undergraduate awardees; 4) Express a strengthened commitment to a research career as a result of the summer program; and 5) Enroll in a graduate or combined graduate/professional program to pursue a career in basic biomedical research.

**Evaluation Methods & Results:** The program is evaluated by participant surveys at the beginning and end of the fellowship period, follow-up surveys at 2- and 4-year intervals, and reports, abstracts, and interactive, online assignments produced by the fellows. Since its launch in 2000, 109 undergraduates have received fellowships. Nearly all (92%) attended the Experimental Biology meeting and presented a poster. More than a third published a paper on their fellowship research.

**Dissemination Activities & Plans to Disseminate:** The program information is shared via the APS website and external funding to double the size the program is being solicited.

**Impacts of Project or Anticipated Impact:** The 2-year post-fellowship surveys indicate that 85% of the UGSRFs had graduated and, of these, 46% applied to graduate school (PhD or Master's programs) and 74% were accepted. More than half (58%) applied to a science-related professional school (MD, etc.) and 75% of the applicants were accepted. At the time of the survey, most (78%) were already enrolled in a graduate or professional degree program.

**Challenges:** The Experimental Biology meeting often conflicts with students' final exams, making it difficult for them to attend the full meeting. Staff works with students to try to resolve travel difficulties. Tying to track students for 4 years post-fellowship also is difficult. Students share their home addresses as well as campus addresses to help staff locate them in subsequent years.

**Abstract:** Undergraduate Summer Research Fellowship Program: Exposing Undergraduates to Physiology Research Leads to a Research-focused Career

The APS Undergraduate Summer Research Fellowship (UGSRF) program seeks to excite and encourage undergraduate (UG) students worldwide to pursue a career as a basic research scientist. The APS funds 24 students annually for a full-time summer research experience, interactive online assignments on research skills and career development, and a travel fellowship to attend Experimental Biology.

As a result of the program, students: 1) Learn to develop a hypothesis-driven research project, collect and analyze data, and write up the experimental results; 2) Present at least one poster or oral presentation on their experimental results at a scientific meeting; 3) Attend a national multi-society scientific meeting and interact with fellow undergraduate awardees; 4) Express a strengthened commitment to a research career as a result of the summer program; and 5) Enroll in a graduate or combined graduate/professional program to pursue a career in basic biomedical research.

The program is evaluated by participant surveys at the beginning and end of the fellowship period, follow-up surveys at 2- and 4-year intervals, and reports, abstracts, and interactive, online assignments produced by the fellows. Since its launch in 2000, 109 undergraduates have received fellowships.
Nearly all (92%) attended the Experimental Biology meeting and presented a poster. More than a third published a paper on their fellowship research. The 2-year post-fellowship surveys indicate that 85% of the UGSRFs had graduated and, of these, 46% applied to graduate school (PhD or Master’s programs) and 74% were accepted. More than half (58%) applied to a science-related professional school (MD, etc.) and 75% of the applicants were accepted. At the time of the survey, most (78%) were already enrolled in a graduate or professional degree program.

**Poster #111**
**Category:** A5
**Primary Project or Approach:** Other: Facilitating and supporting student research and discovery of new and interdisciplinary ecological approaches
**Institution:** Ecological Society of America
**Presenter:** Katherine McCarter
**Email:** ksm@esa.org
**Field of Interest within Biology:** Ecology and Environmental Biology

**Goals & Intended Outcome:** The SEEDS program was established to diversify and advance the profession of ecology through opportunities that stimulate and nurture the interest of undergraduate students who are underrepresented in ecology.

**Methods & Strategies:** Sponsored opportunities include field trips, undergraduate research fellowships, ESA Annual Meeting travel awards, an annual Leadership Meeting and campus ecology chapters. Each experience broadens and deepens the student’s understanding of ecology and potential careers.

**Evaluation Methods & Results:** Participant surveys are employed after each opportunity to gauge the change in perception of ecology and the utility of the mentoring experience. SEEDS also tracks the long term academic and career pathways of participants through annual surveys.

**Dissemination Activities & Plans to Disseminate:** SEEDS works ESA members to mentor students and with LTER and other field stations to host field trips. Plans include communicating with PIs who have received NSF funding from the Division of Environmental Biology to recruit diverse students into supplemental REU opportunities.

**Impacts of Project or Anticipated Impact:** Since 2002 when SEEDS re-structured its program to offer our signature sponsored opportunities, we have served 346 students directly and thousands more through our ever expanding campus chapter network, now 53-strong. Our 2009 survey (N=75) shows that about 64% of students who have participated in nationally organized SEEDS activities have graduated. Of these, 44% are pursuing a graduate degree and 56% are employed. Overall, the survey indicated that 89% of our alumni have chosen to stay in ecology-related fields or have found ways to apply ecological knowledge in their professions.

**Challenges:** Attracting minority students into ecology remain a challenge. Minority students often participate in the biomedical courses where ecology is not a significant part of the curriculum. Promoting interdisciplinary ideas and participating in forums such as this Visions and Change meeting is a part of a critical process. SEEDS is the only national program dedicated to the mentoring of future ecologists. Funding for this level of mentoring that SEEDS offers remain a challenge. Various fundraising strategies and partnerships are currently being developed.
Poster #112
Category: A5
Primary Project or Approach: Other: Peer-reviewed articles featured in the Journal of Microbiology and Biology Education
Institution: Kent State University
Presenter: Christopher Woolverton
Email: cwoolver@kent.edu
Co-Presenter: Amy Chang, American Society for Microbiology
Field of Interest within Biology: Microbiology, Virology

Goals & Intended Outcome: The Journal of Microbiology and Biology Education is sponsored by the American Society of Microbiology and features articles driven by outcomes-based research in student learning. The journal recognizes educators who are at the forefront of cognitive research in microbiology education.

Methods & Strategies: Traditional peer-review of outcomes-based pedagogical research is used to evaluate novelty, efficacy and impact of teaching and learning methods.

Evaluation Methods & Results: Manuscripts submitted for publication are reviewed by two ad hoc reviewers, a member of the editorial board, and the editor-in-chief. Compiled reviews are evaluated by the editorial board to determine acceptance, acceptance with modification, or rejection.

Dissemination Activities & Plans to Disseminate: Articles accepted for publication are published online in advance of print. Print version of the Journal publishes annually.

Impacts of Project or Anticipated Impact: In its 10th year, the Journal of Microbiology and Biology Education (formerly the Journal of Microbiology Education) has published numerous articles that feature novel pedagogical methods, as well as retooled traditional methods, that have been assessed and determined to have sound efficacy in teaching and learning. The Journal has been a valued forum for sharing successful teaching strategies and has been a recognized source of sound pedagogical research.

Challenges: Challenges have included author adherence to the Journal's scope. This is resolved by communication with the author.

Poster #113
Category: A5
Primary Project or Approach: Other: Increasing student success through a boot-camp program
Institution: Louisiana State University
Presenter: William Wischusen
Email: ewischu@lsu.edu
Co-Presenter: Sheri Wischusen, Louisiana State University
Field of Interest within Biology: General Biology

Goals & Intended Outcome: Our goal was improve student success and retention in the major through a 5-day boot camp program prior to their first college semester.

Methods & Strategies: This program involved an intensive introduction to college courses and the approaches that will lead to student success. It includes lectures, exams, study skills development, peer mentoring, and exposure to opportunities across campus including research.
**Evaluation Methods & Results:** Students in the BIOS program were tracked during the remainder of their time at LSU. We specifically looked at success in core courses within the major, choice of major and time to degree. Students participating in the BIOS program performed better in their introductory biology courses, had a significantly higher rate of retention in the major, and a higher 4-year graduation rate (44% versus 28%) when compared to the control group. The control group consisted of students who were academically matched (HS GPS, ACT score, and gender) and students who had been the BIOS wait-list, but did not participate in the program.

**Dissemination Activities & Plans to Disseminate:** The some of the results of this program have been published and we continue to look for dissemination opportunities. Wischusen, S. M., E. W. Wischusen, and S. M. Pomarico. 2009 Impact of a Short Pre-Freshman Program on Retention. Journal of College Student Retention: Research, Theory and Practice, in press.

**Impacts of Project or Anticipated Impact:** The success of this program has lead to several outcomes including expanding the program from 60 students to 300 students, the development of similar programs in other departments in our college (Physics, Chemistry, and Computer Science), and at other universities (e.g. University of Washington).

**Poster 114**
**Category:** A5
**Primary Project or Approach:** Other: Integrating evolution throughout biology
**Institution:** National Center for Science Education
**Presenter:** Eugenie Scott
**Email:** scott@ncseweb.org
**Co-Presenter:** Louise S. Mead and Steven F. Newton, National Center for Science Education

**Field of Interest within Biology:** Evolutionary Biology

**Goals & Intended Outcome:** To integrate evolution throughout all undergraduate biology course curriculum.

**Methods & Strategies:** Providing specific examples in various subdisciplines, encouraging faculty to incorporate these examples into their courses.

**Evaluation Methods & Results:** A database of such examples that faculty can easily incorporate.

**Dissemination Activities & Plans to Disseminate:** Interactions and resource sharing with other projects seeking to integrate evolution across the curriculum.

**Impacts of Project or Anticipated Impact:** Evolution is a foundational organizing principle in biology. If biology is taught only as facts, without evolution, students lack the framework to understand biology deeply, to make and test predictions, and to understand how and why organisms exist as they do. Exemplars that can be easily adapted for topics such as cells and chemistry of life can facilitate such integration.

**Challenges:** Helping students understand the nature of science and common misconceptions about evolution will help deal with challenges.

**Abstract:** Got Evolution? The Importance of Integrating Evolution across the Biology Curriculum
Each major topic in an introductory biology course, and each chapter in a biology textbook, should demonstrate how evolution informs our understanding of biology. When considering undergraduate education in biology, particularly with reference to evolution, it is difficult to escape the famous quote by Theodosius Dobzhansky, “Nothing in biology makes sense except in the light of evolution”. Dobzhansky further eluci-
dated the importance of evolution when he stated, “Seen in the light of evolution, biology is, perhaps, in-
tellectually the most satisfying and inspiring science. Without that light it becomes a pile of sundry facts, 
some of them interesting or curious but making no meaningful picture as a whole.” Undergraduates need 
to learn the basic facts – the chemicals of life, parts of the cell, Mendelian genetics, the structure and func-
tion of tissues, and organs. But if these facts are taught without evolution, students lack the framework to
understand biology deeply, to make and test predictions, and to understand how and why organisms exist
as they do. We present examples of how to include evolution in the curriculum. We encourage faculty
across disciplines to share their ideas with colleagues to ensure students learn evolution as the foundation
of biology.

Poster #115
Category: A5
Primary Project or Approach: Other: Increase the number of science students who complete a 4-
year degree
Institution: Purchase College, SUNY
Presenter: Joanne Tillotson
Email: joanne.tillotson@purchase.edu
Co-Presenter: Joseph Skrivanek, Purchase College, SUNY
Field of Interest within Biology: Molecular Biology & Biochemistry

Goals & Intended Outcome: RSVP is an NSF-funded program designed to increase the number of
science students who complete the 4-year degree.

Methods & Strategies: Three strategies have been employed to meet our overall objective: com-
munity college initiatives, programs to foster innovative pedagogy in introductory STEM courses, and pro-
grams to improve retention of science students.

Evaluation Methods & Results: Eighty-three percent of students have received AA/AS degrees
(compared with 30% nationally), 71% are completing BA/BS degrees (compared with 13% nationally)
and 33% are pursuing post-baccalaureate studies. Faculty pedagogy workshops led to 60% of atten-
dees changing their STEM courses. Retention strategies have resulted in a 13% increase in freshman
to sophomore retention at Purchase.

Dissemination Activities & Plans to Disseminate: Reports have been made at the NSF Project
Directors meeting, the NIH MORE Project Directors meeting, and professional meetings such as the
American Chemical Society.

Impacts of Project or Anticipated Impact: Increased retention of students at the 4-year college
plus large increases in community college students who transfer to a 4-year institution, complete the 4-
year degree, and pursue graduate education, are all indicative of the success of this program in in-
creasing the number of scientists.

Challenges: An (unexpectedly) large percentage of community college students have transferred to
4-year institutions other than Purchase College, making it a challenge to track their progress toward
the baccalaureate degree and/or graduate degrees.

Abstract: Research and Science Visions Preparation Program (RSVP): A model for two-year to four-
year collaborations. RSVP is an NSF-funded program designed to increase the number of science stu-
dents who complete the 4-year degree, and represents a successful collaboration between Purchase
College, State University of New York, and the community colleges of Dutchess, Orange, Rockland,
Westchester, Nassau and Sullivan counties. In the first four years of the program, 90% of the RSVP
students were biology majors. Three strategies have been employed to meet our overall objective:
community college initiatives, programs to foster innovative pedagogy in introductory STEM courses, and programs to improve retention of science students. Community College initiatives include streamlined transfer opportunities, academic support, scholarships and a summer research program. The summer program is a five-week paid intensive research experience at Purchase College that provides a close mentoring relationship with a faculty scientist. Eighty-three percent of students have received AA/AS degrees (compared with 30% nationally), 71% are completing BA/BS degrees (compared with 13% nationally) and 33% are pursuing post-baccalaureate studies. Faculty initiatives designed to improve student learning include pedagogy workshops for faculty, and released-time for faculty to develop/re-design introductory STEM courses. This has mobilized a cadre of about 25 interested faculty; 60% of workshop attendees changed their STEM courses.

Our evaluator is currently involved in assessing the impact of the pedagogy workshops on student learning outcomes. Efforts to improve retention of science students include financial support, academic monitoring, tutoring, and mentoring. This has resulted in a 13% increase in freshman to sophomore retention at Purchase; further analysis to compare community college RSVP participants with a control group is ongoing. Success of this program has involved buy-in from the Purchase College administration and faculty, buy-in from the community colleges, and a flexible funding structure. The RSVP program is intensively coordinated with similar aspects of our Bridges to the Baccalaureate and Baccalaureate & Beyond programs for minority science students and humanities/social science students, respectively, from the community colleges, giving an overall program that is funded from both private and federal sources (NSF, NIH, Pepsico, and private individuals).

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Poster #116
Category: A5

**Primary Project or Approach:** Other: Develop high-quality undergraduate program in conservation studies

**Institution:** Smithsonian Institution

**Presenter:** Jennifer Sevin

**Email:** sevinj@si.edu

**Co-Presenter:** Jennifer Buff, Smithsonian Institution
Anne Marchant, George Mason University

**Field of Interest within Biology:** Ecology and Environmental Biology

**Goals & Intended Outcome:** The project is to develop a high-quality undergraduate program in conservation studies that (1) uses an interdisciplinary approach (2) brings multiple collaborators together (3) provides participants with a strong foundation in conservation (3) leads to internships and inspires students to pursue graduate study.

**Methods & Strategies:** The program is based on a partnership between an academic institution and a research institution and employs hands-on laboratory and field activities.

**Evaluation Methods & Results:** Multiple assessment strategies are employed. The students complete a pre- and post- SALG survey and are surveyed every 3 weeks throughout the term. Additionally, they are interviewed by faculty to review their academic goals twice during the term. A post semester group meeting and teaching evaluations are also used. Follow up with program graduates has shown that students are successful in obtaining internships and admission to graduate programs. Instructors and others conducting the semester also provide feedback.

**Dissemination Activities & Plans to Disseminate:** We encourage similar partnerships between universities and zoos/museums/wildlife management programs to provide students with an experienc-
tial learning environment. A paper was presented at ESA in 2008. A poster was presented at SENCER in 2009.

**Impacts of Project or Anticipated Impact:** We expect to increase the number of conservation practitioners entering the workforce. As a new program (est. Jan 2008), we do not yet have confirming data.

**Challenges:** We have found that there are bureaucratic barriers that make it difficult for students from other institutions to attend the program. We are developing articulation agreements to overcome these barriers.

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**Poster #117**  
**Category:** A5  
**Primary Project or Approach:** Other: New Course providing research, not a traditional course  
**Institution:** Stony Brook University  
**Presenter:** Marvin H. O'Neal, III  
**Email:** moneal@notes.cc.sunysb.edu  
**Field of Interest within Biology:** General Biology

**Goals & Intended Outcome:** The goals of our project (PREPARE) are to provide an authentic research experience to undergraduates, to increase the number of undergraduates in faculty research laboratories at our university, and to increase the number of graduates interested in pursuing a career in research.

**Methods & Strategies:** PREPARE is a team-based research project that guides a student from scientific question to publication. Students use the construction of a physical model of a protein as a cornerstone project for an introduction to research. They are mentored by research faculty who guide the development of the model and its presentation at a scientific meeting and on Proteopedia.

**Evaluation Methods & Results:** PREPARE was piloted this past spring semester to 16 students as a 400 level 2 credit research course. We collected broad data from each student during the application process including their academic major, overall GPA, previous academic performance in specific science courses, interest in research, experience in a laboratory, etc. We surveyed the students at the beginning and end of the course with the Scientific Attitude Inventory. We evaluated the skills and knowledge of students during the course using exams, competencies, and presentations. We will track their participation in faculty research labs at our university; and we will track their career decisions immediately after graduation.

**Dissemination Activities & Plans to Disseminate:** PREPARE students are required to publish their work in two places: 1) as an abstract and poster at a local and/or national scientific meeting and 2) on Proteopedia which targets a broader scientific audience (from the website: "Proteopedia is a 3D, interactive encyclopedia of proteins, RNA, DNA and other molecules").

**Impacts of Project or Anticipated Impact:** Our short term impact will be to increase the number of undergraduates who are working with research faculty. We anticipate that students will be more prepared for a research opportunity after taking our course. The long term impact will be to increase the quality, quantity and diversity of the pool of national scientists.

**Challenges:** We attracted over 80 students for this coming fall and will need to greatly expand this course to meet the demand. This will require an increase in faculty mentors, an increase in the number of physical models that are constructed, and an increase in instructors to teach the course. We are pursuing extramural funding.
**Poster #118**  
**Category: A5**  
**Primary Project or Approach:** Other: Student research, service learning, lecture course re-design  
**Institution:** Truman State University  
**Presenter:** Cynthia Cooper  
**Email:** clcooper@truman.edu  
**Co-Presenter(s):** Diane Janick-Buckner, Timothy Walston, and Brenda Moore, Truman State University  
**Field of Interest within Biology:** Microbiology, Virology  

**Goals & Intended Outcome:** The purpose of the presentation is to showcase four effective strategies in place at Truman State that improve student learning in biology education.

**Methods & Strategies:** 1) original research projects embedded in the lab courses for advanced biology electives, 2) service learning and community; research embedded in the lab course of a required microbiology course, 3) mathematical biology as an optional minor for biology or math majors, 4) complete course re-redesign in a survey course for non-majors; course sections with and without course re-design.  

**Evaluation Methods & Results:** Course evaluation surveys have been (or will be) implemented in all of the courses.

**Dissemination Activities & Plans to Disseminate:** The pedagogical activities have not been published to date. However, some original research data has been published in peer-reviewed research articles. Plans included manuscript preparation for all the described teaching innovations.

**Impacts of Project or Anticipated Impact:** Three of the course strategies (1-3) have provided anecdotal evidence for student and instructor satisfaction. The course re-design is in place for fall 2009 and no assessment data or impact is available at this time.

**Challenges:** Unexpected challenges include the red tape associated with Institutional Review Boards, motivating students to complete certain course assessments, student preparedness for real research varies, and bridging gaps in the math/biology divide. For the course re-design we expect students will be surprised and struggle somewhat with the new learning environment.

**Abstract:** Innovative Biology Education at Truman State University  

We report on four different approaches at Truman State University that are either in place or planned for this fall that we think help ‘transform’ biology education for undergraduate students. First, and in place the longest is that several faculty utilize original research projects for the lab portion of a few advanced elective biology courses such as Immunology and Molecular Genetics. The research data obtained by the classes has been utilized in several peer reviewed publications and one master’s thesis. Secondly, several faculty members have utilized community research and/or service learning in several courses.

In one case, the service learning and community research takes place in a non-majors microbiology course. In another case, the service takes the form of student designed research or service projects as part of an environmental science course. Thirdly, is the development and implementation of a new minor for biology and math majors, the Mathematical Biology Minor. As biology becomes more computational, this option helps students become competent at the forefront of computational biology research. Students also see the connections between the mathematics requirements in the major and applications of those skills in the biology profession.
The fourth innovation to transform biology education for undergraduates is a pilot study to redesign a few sections of the introductory survey biology course for non-majors. The redesigned sections will reduce the lecture time and increase out-of-class learning options with the aid of computer technologies, directed study, and web material such as those available from www.merlot.org.

Poster #119
Category: A5
Primary Project or Approach: Other: Student research, service learning, lecture course re-design
Institution: Truman State University
Presenter: Cynthia Cooper
Email: clcooper@truman.edu
Co-Presenter(s): Laura Regassa and Teresa Brandon, Truman State University
Field of Interest within Biology: Microbiology, Virology

Goals & Intended Outcome: The purpose of the presentation is to showcase the importance of assessing what we do in biology education.

Methods & Strategies: 1) evaluate the effectiveness of project-based learning to help students retain knowledge, gain confidence and abilities in laboratory techniques, and develop analysis and synthesis skills, 2) evaluate effectiveness of service learning and 3) evaluate effectiveness of electronic portfolio to integrate student learning.

Evaluation Methods & Results: Assessment tools included concept knowledge assessment, analysis of critical thinking/problem solving skills, writing sample clarity, student self-assessment of laboratory skills, student focus groups, and reflective analysis.

Dissemination Activities & Plans to Disseminate: All three authors have presented their studies at the microbiology educator's conference (ASMCUE) and two of us have published articles that include assessment in education journals. We continue to assess our teaching practice with the goal of publishing in peer-reviewed education journals.

Impacts of Project or Anticipated Impact: A major impact of assessing student learning is course improvement and greater instructor satisfaction, although this has not been formally assessed.

Challenges: Unexpected challenges include the variation in expectations from Institutional Review Boards and motivating students to complete certain course assessments.

Abstract: Transforming Biology Education: Assessing What We Do
Three different pedagogical approaches with assessment of student learning is presented. The purpose of the presentation is to showcase the importance of assessing what we do in biology education. The first study utilized a project-based approach in a molecular biology course to enhance instruction of experimental methods and analytical skills. The second case shows assessment of service learning in a microbiology lab course. The third study involved integrative learning using the electronic portfolio in a microbiology course. In all cases, the instructional approaches were evaluated to determine their efficacy for increased student learning. All three authors are alumni of the 2005 class of Scholars-In-Residence sponsored by the American Society for Microbiology.
Poster #120
Category: A5
Primary Project or Approach: Other: Success skills for student retention
Institution: University of Arizona
Presenter: Gail Burd
Email: gburd@email.arizona.edu
Co-Presenter: Shelley McGrath, University of Arizona
Field of Interest within Biology: All "biology" programs in College of Science

Goals & Intended Outcome: The goal of a mandatory success course for freshman students on probation was to help these students get off academic probation and persist through college. The intended outcomes included an increase in their cumulative GPA and persistence through to their fourth year of college and ultimately graduation.

Methods & Strategies: The course serves as an intervention taught by academic advisors to assist students in developing the skills necessary to succeed in college. Those skills include study/note-taking/test-taking skills, time management, introspection, self-awareness, and developing relationships with faculty and advisors.

Evaluation Methods & Results: A longitudinal study compared the persistence and performance rates of students who took the course to those who did not. The treatment group consisted of members of a cohort (students enrolled for fall 2004 and 2005 terms) who were offered the course and the control group consisted of members of a cohort (students enrolled for fall 2002 and 2003 terms) who were not offered the course because it did not yet exist. The results revealed a marked increase in first-year cumulative GPA, persistence rates, and regaining good standing in a short period of time for all majors in the College of Science including the Biology majors.

Dissemination Activities & Plans to Disseminate: We are submitting a manuscript for publication this summer.

Impacts of Project or Anticipated Impact: The impact of this project led to a significant increase in the retention of students who went on academic probation during their first semester as a biology student. Also, many other colleges and departments offer similar courses in order to effect similar outcomes for their students.

Challenges: Some unexpected challenges have included a certain level of resistance toward success courses. Most of resistance has come because non-faculty advisors taught the courses and some of the courses earn a letter grade or can be used as credit toward a degree program. In addition, unlike our course, most of the other success courses have not assessed student retention outcomes. The campus has formed a sub-committee to resolve these issues and to reach reasonable compromises.

Poster #121
Category: A5
Primary Project or Approach: Other: Quantitative curriculum prepares undergraduate health science majors to careers in health sciences and biotechnology
Institution: University of Minnesota Rochester
Presenter: Claudia Neuhauser
Email: neuha001@umn.edu
Field of Interest within Biology: Statistics and Health Sciences
**Goals & Intended Outcome:** The curriculum at the University of Minnesota Rochester prepares undergraduate students in a health science major for a wide variety of careers in the health sciences and biotechnology. The quantitative curriculum emphasizes authentic data sets and active learning.

**Methods & Strategies:** The statistics course relies on authentic data sets, active learning, group projects, and integration of health sciences topics.

**Evaluation Methods & Results:** A comprehensive 4-year assessment plan is currently developed by faculty at UMR. The assessment is concept-based to allow tracking of student performance during the four years stratified by concepts. Data mining methods will be developed to determine patterns of learning. Assessment will be used to guide student learning and to improve the curriculum.

**Dissemination Activities & Plans to Disseminate:** The entire curriculum will be made available online. Much of the quantitative curriculum is available on the presenter's web page: http://bioquest.org/numberscount/

**Impacts of Project or Anticipated Impact:** The curriculum will be offered starting Fall 2009. The close integration of assessment and curriculum should improve student performance. The concept-based approach should make the curriculum more transparent to students. The integration of student development and career advising should result in more informed career choices. The streamlined curriculum that relies on common courses during the first 2-3 years should allow students to become informed about careers before selecting a career path, thus reducing the “starting-over” effect.

**Challenges:** The pedagogy is novel to more traditional faculty and we encountered resistance during the approval process. This was largely overcome by presenting case studies and data from other institutions where inquiry-based and project-based instruction has been a longer tradition.

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**Poster #122**

**Category:** A5  
**Primary Project or Approach:** Other: Integrating Writing into Science Curriculum  
**Institution:** University of Washington Tacoma  
**Presenter:** Erica Cline  
**Email:** ecline@u.washington.edu  
**Co-Presenter:** Peter Selkin, University of Washington Tacoma  
**Field of Interest within Biology:** Ecology and Environmental Biology

**Goals & Intended Outcome:** Our goal was to implement a curriculum-wide, scaffolded approach to teaching scientific writing, integrated into each of the introductory science courses including the introductory biology sequence.

**Methods & Strategies:** Supported by an internal “Writing Across the Curriculum” Initiative and a yearlong Writing Institute providing science faculty with exposure to the latest research on effective writing instruction, we developed a series of writing assignments woven throughout the introductory science curriculum.

**Evaluation Methods & Results:** Effectiveness of writing exercises has been evaluated through midterm and end-of-quarter surveys assessing student perceptions of learning. We intend to assess long-term success in advanced undergraduate courses through post-graduation surveys and a comparison of students who have completed the curriculum with those who transfer in to upper-division courses without completing our introductory science curriculum.
**Dissemination Activities & Plans to Disseminate:** We have presented these results to colleagues in the Geosciences community at the American Geophysical Union 2008 annual conference.

**Impacts of Project or Anticipated Impact:** We anticipate that students completing the introductory science curriculum will have an easier transition to advanced coursework requiring independent analysis and disciplinary science writing skills.

**Challenges:** The greatest challenge is to discover efficiencies of time (both instructor’s grading time and classroom instruction time). It is always a challenge to balance the need for classroom time for skills development with time required to cover content that is required for success in advanced courses.

**Abstract:** Integrating writing into the introductory biology curriculum: Perspectives from an interdisciplinary environmental sciences program.

In the University of Washington Tacoma's Environmental Science program, we have implemented a curriculum-wide, scaffolded approach to teaching scientific writing, integrated into each of the introductory science courses including the introductory biology sequence. This curriculum development was supported by a ‘Writing Across the Curriculum’ Initiative and a yearlong Writing Institute that provided science faculty with exposure to the latest ideas and research on effective writing instruction. Writing can serve as a powerful tool to deepen students’ engagement with disciplinary content, to help students feel part of the scientific community, and to recruit students into the process of scientific inquiry. The centerpiece of our approach is a series of research and writing assignments woven throughout the introductory science courses. The assignments progress in their degree of complexity and freedom throughout the sequence. For example, throughout the three-quarter biology sequence, students begin by gathering field data as part of a pre-designed research study and progress to designing their own study; they begin with a guided data analysis of class results and progress to gathering and analyzing their own data independently, and they are initially exposed to the primary research report format in a highly structured sequence of small exercises, building to independently writing their own primary research paper. Emphasis is placed on guiding the student to understand the unique characteristics and requirements of disciplinary writing within the sciences. Each assignment is supported by a number of worksheets and short written exercises designed to teach writing and critical thought skills. The assignments challenge students to personalize their understanding of basic science concepts, and to think critically about ideas that interest them. We find that these assignments provide a good way to assess student comprehension of some of the more difficult ideas in the basic sciences, as well as a means to engage students with the challenging concepts of introductory science courses. While this program is uniquely suited to our interdisciplinary environmental science curriculum, it has direct relevance to, and could easily be adapted for, more traditional introductory biology majors sequences.

**Poster #123**

**Category:** A5

**Primary Project or Approach:** Other: Preparing Disadvantaged High School Students for Undergraduate Biology Courses

**Institution:** Washington University School of Medicine

**Presenter:** Britney Moss

**Email:** blmoss@artsci.wustl.edu

**Co-Presenter:** Dr. Thomas Woolsey, Washington University School of Medicine

**Field of Interest within Biology:** Cell Biology

**Goals & Intended Outcome:** The Young Scientist Program (YSP) seeks to recruit disadvantaged
high school students into science careers through hands-on research and one-on-one interactions with scientists. During the summer, students participate in research and coursework to prepare them for college-level biology and science courses.

**Methods & Strategies:** YSP uses one-on-one interactions between students and PhD or Post-Doctoral research mentors to foster a student's interest in science, as well as a biological research techniques course, a science writing course, journal clubs, and a seminar series to prepare students for undergraduate level coursework.

**Evaluation Methods & Results:** YSP is utilizing pre- and post-activity questionnaires, verbal interviews with participants and volunteers, and online surveys for retrospective assessment every 5 years to track both former students and volunteers. Howard Hughes Medical Institute grant funding has allowed YSP to hire a professional assessment firm to assist with implementing new assessment techniques and improving existing ones.

**Dissemination Activities & Plans to Disseminate:** YSP volunteers have presented at several national science meetings, as well as published our work in a 2006 issue of Science. We have recently assisted in submitting a proposal to present our work in an education forum at the 2010 AAAS meeting.

**Impacts of Project or Anticipated Impact:** So far, of the 200 students who have participated in YSP's summer research internship, approximately 70% have gone on to choose science majors in college and are planning careers in science or science-related fields. We anticipate that continued tracking of these students will show placement in science-related careers. Furthermore, YSP is also tracking the careers of former volunteers and seeks to assess the impact that participation in YSP has on career choice and involvement in undergraduate, graduate, and community science education activities.

**Challenges:** Tracking former participants has proven challenging, especially due to the high mobility rates of students and their families. Recently, social networking websites have proven a valuable asset in tracking down and staying in touch with former YSP participants.

**Abstract:** "Preparing Disadvantaged High School Students for Undergraduate-Level Science Coursework"

For almost twenty years the Young Scientist Program (YSP) at the Washington University School of Medicine has been providing paid summer research experiences for local high school students from disadvantaged backgrounds. The goal of this program has been to promote science literacy and to attract disadvantaged students into scientific careers through hands-on research and one-on-one interactions with scientists. Each student spends the summer in collaboration with a PhD student or post-doctoral research mentor on a research project. High school students participate in various activities over the summer that prepare them for college-level biology and science courses. These include a two-day science bootcamp, where students learn basic lab skills and critical thinking, in the format of an undergraduate biology lab course, and a summer-long science writing course that ends with students writing a short research paper about their summer project. At the end of the summer they give an oral presentation of their research findings to an audience that includes their mentors, tutors, faculty sponsors, teachers, and parents. Approximately 70% of the nearly 200 student participants to date have chosen science majors in college and are planning careers in science/science related fields. Recently, YSP has begun offering paid summer internships to former program participants who are now in college, to continue fostering their interest in science and research. Furthermore, YSP also sends teams of volunteers into local high schools for interactive science demonstrations and brings high school groups onto the Washington University campuses to tour lab facilities, see state of the art technology, and interact with scientists in a medical school/research university setting.
Poster #124
Category: B1
Primary Project or Approach: Assessment (Concept Inventories, critical thinking, other)
Institution: Chadron State College
Presenter: Ann Marie Buchmann
Email: abuchmann@csc.edu
Co-Presenter: Joyce Phillips Hardy, Chadron State College
Field of Interest within Biology: General Biology

Goals & Intended Outcome: The goals of this project are to increase the student’s ability to read, synthesize, and critically assess primary literature. This project is also used for departmental assessment of student learning.

Methods & Strategies: The project is a two semester capstone course in literature reading and writing. Students learn about peer review and the process of doing science. Students then read the primary literature on a topic of their choice and prepare a poster, a literature review, and a presentation synthesizing the available scientific information.

Evaluation Methods & Results: Students are evaluated by multiple faculty members using rubrics. The results show that while students synthesize the material well, they have major misconceptions on evolutionary topics, and they have difficulties understanding how to write in an appropriate technical style.

Dissemination Activities & Plans to Disseminate: This course is required for all graduating seniors. The assessment data gathered is used in discussions with other faculty members about curriculum and program changes.

Impacts of Project or Anticipated Impact: The project has had an impact on the curriculum taught within the department and has lead to the development of an Evolution class and to more integration of technical and scientific writing within the biology curriculum.

Challenges: The biggest challenge is the development of technical and scientific writing skills. The composition courses currently available at the college focus on non-technical writing, and lower level science courses seldom have extensive writing assignments. To deal with this problem, literature reading and review have been included in several upper level and a few lower level classes including Immunology, Molecular Biology, Developmental Biology, Zoology, and Cell Biology.

Abstract: Teaching and Assessing the Silent Curriculum
Communication and critical thinking skills are crucial for biology professionals — yet these are difficult skills to teach and assess. Our program includes an intense two-semester capstone course designed to teach students to read and analyze primary literature. Each student must integrate knowledge across several fields to produce a poster, a major presentation, and a literature review examining scientific data on a topic of her or his choosing. This capstone series effectively enhances scientific maturity and professionalism while providing effective program assessment.

Poster #125
Category: B1
Primary Project or Approach: Assessment (Concept Inventories, critical thinking, other)
Institution: Iowa State University & ACS Examinations Institute
Presenter: Thomas Holme
Email: taholme@iastate.edu
Field of Interest within Biology: Assessment of Learning

Goals & Intended Outcome: We have built a collaboration of 8 NSF funded projects in chemistry assessment to look at building a model for data-driven reform of chemistry education. The ability to have multiple schools and research groups working towards this end leverages many important aspects of change paradigms in education.

Methods & Strategies: We use cross validation studies (over partner academic institutions) for instruments that have been developed and discussions about how experience with assessment in some areas can be used to direct new instruments in areas that have been afforded less attention.

Evaluation Methods & Results: In addition to ongoing discussions within the team, an external evaluator works with the entire group. This process includes a continuous meta-analysis of the efforts to identify new ways in which the putative synergies of the large collaboration can be put to best use.

Dissemination Activities & Plans to Disseminate: Conference reports represent the primary dissemination activities at this point. Ultimately, the American Chemical Society Examinations Institute will be able to provide additional dissemination.

Impacts of Project or Anticipated Impact: Immediate impacts have been to identify challenges associated with continued refinement of assessment instruments. In the long term, the project envisions a spiral methodology for curricular reform. Ideas for new teaching methods or content coverage demand new assessment methods. Data from the new assessments provide insights for interventions that improve teaching and learning. These new interventions drive needs for assessment, which in turn push teaching practice. This model can be replicated in any environment and does not imply there is a single "correct" way to teach, but rather provides a process by which refinement of teaching occurs within a data-driven paradigm.

Challenges: When new data suggests that assessment instrument require further refinement, it is a challenge to "give up" on the established work. Discussions with all stakeholders provides important brainstorming efforts that allow progress to occur.

Poster #126
Category: B1
Primary Project or Approach: Assessment (Concept Inventories, critical thinking, other)
Institution: Michigan State University
Presenter: John Merrill
Email: merrill3@msu.edu
Co-Presenter: Kevin Haudek, Rosa Moscarella, and Mark Urban-Lurain; Michigan State Univ.
Field of Interest within Biology: Marine Biology

Goals & Intended Outcome: Our goal is to strengthen assessments in undergraduate STEM courses with emphasis on revealing students' conceptual thinking. Time and resources often prevent instructors from using constructed response assessments (essay questions) in large undergraduate science courses. Yet, constructed responses can reveal student conceptual thinking better than multiple choice questions.

Methods & Strategies: We are investigating the use of computerized lexical analysis and statistical classification techniques to categorize and evaluate student responses. We collected written responses to a question regarding strong and weak acids from 382 students enrolled in an introductory biology course.
**Evaluation Methods & Results:** We used Lexical Analysis (LA) software with a custom library of science-related terms to produce 23 unique term categories for the student responses. Although LA can rapidly and accurately provide an instructor with a statistical overview of the terms and categories of terms used by students, and is therefore useful in guiding instruction (Moscarella, et al., 2008), LA cannot by itself evaluate the “correctness” of the responses. In order to accomplish the latter, we undertook additional steps. First, two expert human scorers rated 150 student responses using a 3-bin scoring rubric. We then applied statistical Discriminant Analysis (DA), which attempts to define functions relating the LA categories to the expert scoring. Our results show that DA could predict human scoring with over 86% accuracy.

**Dissemination Activities & Plans to Disseminate:** We are currently extending these preliminary findings with additional assessment items, in particular in the areas of cell metabolism and natural selection.

**Impacts of Project or Anticipated Impact:** The approaches we have developed may be most useful when used in conjunction with standardized assessments, such as concept inventories and diagnostic question clusters, where the significant one-time effort required to produce the customized LA dictionaries can be offset by reusability across time and across institutions. We plan to partner in future work with developers of such assessment instruments.

**Challenges:** Development of LA libraries is a significant undertaking and is not likely to be suitable for routine "one-off" assessment items. Rather, the effort devoted to library construction will only be justified for reusable assessments such as concept inventories and diagnostic clusters.

**Abstract:** Beyond Multiple Choice: Automated Analysis of Essay Questions

Time and resources often prevent instructors from using constructed response assessments (essay questions) in large undergraduate science courses. Yet, constructed responses can reveal student conceptual thinking better than multiple choice questions. We are investigating the use of computerized lexical analysis and statistical classification techniques to categorize student responses. We collected 382 student written responses to a question regarding strong and weak acids. We used Lexical Analysis (LA) software (“SPSS Text Analysis for Surveys”), with a custom library of science-related terms to produce 23 unique term categories for the student responses. Although LA can rapidly and accurately provide an instructor with a statistical overview of the terms and categories of terms used by students, and is therefore useful in guiding instruction (Moscarella, et al., 2008), LA cannot by itself evaluate the “correctness” of the responses. In order to accomplish the latter, we undertook additional steps.

First, two expert human scorers rated 150 student responses using a 3-bin scoring rubric. We then applied statistical Discriminant Analysis (DA), which attempts to define functions relating the LA categories to the expert scoring. Our results show that DA could predict human scoring with over 86% accuracy (p<.000). In addition, the classification functions identified a subset of 14 term categories having the most relevance in predicting response scoring. This technique may be most useful when used in conjunction with standardized assessments, such as concept inventories and diagnostic question clusters, where the significant one-time effort required to produce the customized LA dictionaries can be offset by reusability across time and across institutions.

Poster #127
Category: B1
Primary Project or Approach: Assessment (Concept Inventories, critical thinking, other)
Institution: Michigan State University
Presenter: Joyce Parker
Email: parker13@msu.edu
Field of Interest within Biology: General Biology

Goals & Intended Outcome: The goals of our project are to develop a) assessment tasks that re-
veal how students think about introductory biology, particularly their ability to do principled reasoning
and b) instructional interventions to be used throughout a course that improve students' principled
reasoning.

Methods & Strategies: We use an iterative process whereby we a) study students' thinking about ba-
sic biology through analysis of their responses to open-ended questions and interview, b) use that analy-
sis to develop diagnostic multiple choice questions that can be used to study the efficacy of our instruc-
tional interventions.

Evaluation Methods & Results: Both our qualitative and quantitative analyses of students' thinking
about cellular respiration, photosynthesis, and Mendelian genetics indicate that what first appears to be
a mix of misconceptions and nonsensical thoughts, has some patterns: students are very poor at what
we call principled reasoning. Very few students use basic principles such as conservation of matter and
energy to make sense of complex biological processes. Our findings indicate that explicitly and consist-
ently tracing matter, energy, and information, as well as keeping track of scale could provide a useful
framework for student learning of introductory bio.

Dissemination Activities & Plans to Disseminate: We have attended a number of assessment
conferences both for the sciences as well as specifically for biology. We have published in Cell Biology
Education and are about to send in 3 papers to CBE, JRST, and Cognition & Instr. In addition we have
a new grant to work with faculty from other local institutions.

Impacts of Project or Anticipated Impact: Our work is an alternative approach to concept inven-
tories that lead to long lists of misconceptions which seemingly must be dealt with individually. Our
approach of looking for patterns across students’ responses to multiple application questions has led to
a principled reasoning framework that can be used across concepts a) for organizing content to im-
prove students' learning, b) to develop assessment items, and c) interpret students' responses to
those items. Our findings are convincing some local faculty to restructure their instruction around the
principled reasoning framework.

Challenges: As we work across instructional contexts at the local community college, in multiple lev-
els of biology courses in the college of natural science, and in a residential college, we are finding a
number of important contextual differences in students, but more importantly in faculty approaches,
goals, and values that hamper dissemination. We are therefore spending more time involving faculty
in discussions about development of assessment tasks and instructional interventions.

Abstract: Defining Assessing Understanding in Introductory Biology: Principled Reasoning

To improve instruction in introductory biology, we need to define the nature of the understanding we
want students to take away and design assessment tasks that reflect that understanding. The assess-
ment items can then be used to measure the efficacy of changes in instructional strategies and the
defined target understanding can be used to focus instruction.
We began down this road by targeting understanding of biological systems that are involved in respiration, photosynthesis, and Mendelian genetics. In particular we wanted students to be able to apply basic concepts to new contexts. At first glance, many students’ responses to open-ended application questions appeared to defy common sense. Others seemed to be misconceptions growing out of misinterpretations of common experiences. The long and ever growing list of students’ problematic ways of thinking about these topics is daunting and not particularly useful to instructors, since it implies that each problem needs its own intervention.

However, a closer look at students’ writing revealed a pattern that crossed topics: many responses violated simple scientific principles. Students’ explanations had matter disappearing or appearing out of nowhere or changing in ways that violated basic rules of chemistry. Energy came and went without appropriate explanation. When looking at genetics-related responses, information in the form of nucleotide sequences was replicated and changed without regard to very basic rules. This led us to be more specific about the type of reasoning we wanted students to use when explaining phenomena or using standard representations. We use the term principled reasoning to describe a type of understanding where students: provide explanations that are commensurate with a few basic organizing principles as well as knowledge of biological events.

In particular, we found that tracing matter, energy, and/or information along with keeping track of scale are useful organizing principles for cellular biology and genetics.

In our poster, we present sample frameworks of content organized around these principles along with items for assessing students’ ability to do principled reasoning.

**Poster #128**  
**Category:** B1  
**Primary Project or Approach:** Assessment (Concept Inventories, critical thinking, other)  
**Institution:** The Ohio State University  
**Presenter:** Ross Nehm  
**Email:** nehm.1@osu.edu  
**Co-Presenter:** Hendrik Hartig, NWU-Essen, Germany  
Judith Ridgway, The Ohio State University  
**Field of Interest within Biology:** Evolutionary Biology

**Abstract:** Human vs. Computer Diagnosis of Mental Models of Natural Selection: Testing the Efficacy of Lexical Analyses of Open Response Text

Recent reform documents emphasize that STEM educational research must place greater emphasis on the teaching, learning, and assessment of critical content or "core ideas" (NRC, 2001, 2006). These reform documents also highlight the urgent need for assessment tools that harness advances in technology and are guided by cognitive models of progression towards competence. Our project explores a central problem in STEM education—assessing students’ cognitive models of natural selection—that must be addressed in order for substantial progress to be made in the teaching and learning of this important but greatly misunderstood “core idea” in biology. Nehm and colleagues (2007, 2008, and 2009) have developed natural selection measurement models that account for the diversity of "misconceptions" and "key concepts" common to undergraduate students’ mental models of natural selection. They have also documented what may be referred to as the “either or” forced-choice (“misconception” vs. scientific key concept) item constraints endemic to certain multiple-choice tests (like the CINS). Their work has shown that majorities of students harbor heterogeneous mental models of natural selection comprised of both scientifically accurate and inaccurate cognitive elements in myriad permutations. Because of the massive amounts of time, training, and expertise involved in scoring
open-response text, this option has justifiably been abandoned by many STEM educators. But computerized Lexical Analysis (LA) may provide a solution to this problem thereby allowing more valid measurement and diagnosis of student mental models of natural selection.

We empirically tested the efficacy of computerized LA of open-response text relative to human scoring. Specifically, we explored whether LA can diagnose the cognitive elements that comprise students’ mental models of natural selection with equal fidelity as human scorers. We used SPSS Text Analysis 3.0 to perform our LA and measure Kappa values (inter-rater reliability) of cognitive element detection (i.e., computer-human correspondence). We used pre- and post-test responses from the Open Response Instrument of Nehm & Reilly (2007) to test the efficacy of LA.


These analyses illustrate that (1) LA tools can be used successfully to diagnose fine-grained cognitive elements comprising students’ mental models of natural selection from open-response text and (2) LA assessment scores are comparable to human assessment scores. Together, these preliminary results affirm our view of LA as a transformative method for STEM assessment in general and natural selection in particular.

Poster #129
Category: B1
Primary Project or Approach: Assessment (Concept Inventories, Critical Thinking, other)
Institution: The University of Texas at Austin
Presenter: Sarah Simmons
Email: s.l.simmons@mail.utexas.edu
Co-Presenter: Ruth Buskirk, The University of Texas at Austin
Field of Interest within Biology: Molecular Biology & Biochemistry

Goals & Intended Outcome: Our goals are to (i) attract and retain students in the sciences; (ii) improve undergraduate academic success, science literacy and critical thinking skills; (iii) bridge the gap between education and research by using research as a vehicle for teaching; (iv) create an environment in which the effects of research training can be assessed; (v) drive curriculum reform; and (vi) enhance collaborations that merge education and research.

Methods & Strategies: Each year, freshmen are recruited into 3-semester series of courses that count towards their degree and incorporate critical thinking, interaction with faculty, hands-on experimentation, data interpretation, student presentation, publication and peer mentoring. These course are developed from cutting-edge faculty research amenable to large-scale freshman training and experimentation.

Evaluation Methods & Results: Both summative and formative assessment of the project and its components in relation to our stated goals is underway. Our evaluation methods include survey data (student and faculty), student academic tracking and compilation of available data (numbers of scholarships, research for credit) that is relevant to our goals. Our model has already shown great promise in achieving these goals, and preliminary outcomes will be presented.
Dissemination Activities & Plans to Disseminate: Our dissemination plan involves the creation of print, web and video materials as well as conference presentations and public to communicate: 1) the mission and objectives of our program (to students, faculty, industry collaborators and future funding agencies), and 2) the results of our assessment plan with our stakeholders, promoters of undergraduate research and education, other research institutions and the public.

Impacts of Project or Anticipated Impact: This project has already improved student attraction to and retention in the sciences at UT-Austin, impacted the success of the students in our program, been a force for change in the science curriculum, and impacted the culture for undergraduate research and education at our university.

Challenges: To address the challenge of recruiting underrepresented students to take advantage of research opportunities, we have begun improving relationships with area high schools, involving teachers and parents in informational campaigns about research, and by lowering the “cost” of research for the students by aligning it with their courses and career goals. We have overcome many of the challenges related to the “wall” that exists between research and education through a program that truly merges research and education and by serving both missions and finding creative compromises. We are beginning to address the major challenge of sustainability by identifying essential components, how those components fit into existing funding mechanisms (instructional and research) and what external funding must be solicited for the remainder.

Abstract: Teaching through research: The Freshman Research Initiative at The University of Texas at Austin

The College of Natural Sciences at the University of Texas at Austin has commenced a large-scale reinvention of our undergraduate research paradigm. Our new model, the Freshman Research Initiative (FRI), is faculty initiated, involves large numbers of freshmen and is integrated with the curriculum. Each year, freshmen are recruited into an intensive eighteen month set of degree-program courses that incorporate critical thinking, interaction with faculty, hands-on experimentation, data interpretation, student presentation, publication and peer mentoring. Our model incorporates cutting-edge faculty research amenable to large-scale freshman training and experimentation, after which students are experienced in a broad range of techniques in the areas of chemistry, biochemistry, molecular biology, physics, mathematics, or computer science. Originally conceived in response to an NSF Undergraduate Research Center (URC) proposal solicitation, the FRI program is now funded by NSF, HHMI and the University of Texas, and has been running and expanding for 4 years.

This program now offers research experience to over 500 students ~ 25% of each incoming class in the College of Natural Sciences. The core principle behind the Freshman Research Initiative is the merging of the educational and research missions of the University to benefit the undergraduate students and the production of an exportable model for other large research institutions. Our goals for this reformation of undergraduate education, are to (i) attract and retain students in the sciences; (ii) improve undergraduate academic success, science literacy and critical thinking skills; (iii) bridge the gap between education and research by using research as a vehicle for teaching; (iv) create an environment in which the effects of research training can be assessed; (v) drive curriculum reform; and (vi) enhance collaborations that promote education through undergraduate research. Our model has already shown great promise in achieving these goals, and preliminary outcomes will be presented.
Poster #130  
**Category:** B1  
**Primary Project or Approach:** Assessment (Concept Inventories, critical thinking, other)  
**Institution:** The University of Tulsa  
**Presenter:** Peggy Hill  
**Email:** peggy-hill@utulsa.edu  
**Field of Interest within Biology:** Integrative Biology

**Goals & Intended Outcome:** Students explore their initial ethical positions and the basis for each; focus on specific current environmental ethical issues, including the concept of a “land ethic” (e.g. Leopold's view); and learn to think ethically and critically as they develop skills to be incorporated into later work.

**Methods & Strategies:** Students read (about 25 journal articles and two books), write (short essays, a journal, a team report), discuss ideas as a class, and produce a team presentation of a focused project.

**Evaluation Methods & Results:** Students take one exam to test for content knowledge, and there are some lectures, but most class time is spent in discussions of readings that are often student led. They prepare discussion talking points through ideas explored in the journal entries and through preparing answers to topical questions from which they choose a specific number each session to write as short essays.

**Dissemination Activities & Plans to Disseminate:** There has been no formal dissemination to date other than the annual reports to the funding agency sponsoring development of the course. This conference provides a vehicle to gauge interest in further dissemination options.

**Impacts of Project or Anticipated Impact:** The impact has been restricted to campus, and thus has been local in scope. The course has served the needs of students from nine majors other than biology, who represent 23.4% of the total enrollment in seven years.

**Challenges:** The first challenge was in convincing the funding agency that a biologist could direct a course in environmental ethics. We engaged a noted scholar, whose academic appointment is in philosophy, to serve as mentor and outside evaluator as the course was being developed, and he even taught one session in the first year of implementation. He was a terrific sounding board, and his validation of the final syllabus was critical to the success of the effort on multiple levels.

**Abstract:** Academic study of ethics has been standard for almost two decades in business disciplines in colleges and universities across the United States, while ethics in biology has been relegated mostly to short-course examinations of medical ethics. Environmental ethics is considered to be essentially a specialty of philosophers. In 2002 most of the few environmental ethics courses offered in the United States were part of the graduate philosophy curriculum, and undergraduates rarely had an opportunity to study these ideas. Almost no environmental ethics courses were taught by biologists. With funding from the National Science Foundation through its Undergraduate Mentoring in Environmental Biology (UMEB) initiative, the Biological Sciences faculty at the University of Tulsa (OK) attempted to address this issue. Environmental Ethics and Conservation has been taught for 7 years as an upper division elective in Biological Sciences by a behavioral ecologist: 6 years in the summer term, but in 2009 in the spring semester. Course enrollments have ranged from 5 to 18 students, most of whom (76.6%) were Biological Sciences majors. Geosciences and Environmental Policy students each represented 5.2% of the total, while less than 3% of students came from majors in Law, Science Education, Bio-geosciences, Economics, Petroleum Engineering, Chemistry and Exercise Physiology. Students funded by the UMEB grant represented 62.5% of the enrollment in Year 2 of the course but only 6.3% by Year
5 (the program’s last year). Thus, environmental ethics has become established and integrated into
the Biological Sciences curriculum at the University of Tulsa, yet it appeals to students from a number
of disciplines across campus, as well. As we seek to transform undergraduate education in biology, we
might consider the unique perspective that biologists bring to the study of environmental ethics. Biolo-
gists educating biology students and others in environmental ethics may help us move toward achiev-
ing the change we seek as we address environmental problems of the 21st Century.

Poster #131
Category: B1
Primary Project or Approach: Assessment (Concept Inventories, critical thinking, other)
Institution: University of Missouri
Presenter: Bethany Stone
Email: stoneb@missouri.edu
Field of Interest within Biology: General Biology

Goals & Intended Outcome: It is important to establish what students know, where they are con-
fused and where knowledge is completely lacking before designing instructional strategies. The primary
purpose of this project was to assess students’ prior knowledge in molecular genetics, including uncov-
ering misconceptions and their sources.

Methods & Strategies: Students (350) in a non-majors introductory biology lecture course com-
pleted pre- and post-instructional assessments on basic concepts in molecular genetics. The tools
measured their understanding, their confidence in that understanding, sources (other classes, books,
TV, news, etc.) and their general attitudes.

Evaluation Methods & Results: The majority of students had confidence in their misconception that
a gene or a chromosome was a rung on the DNA ladder and that different cells in the same person will
have different genes or DNA sequence. Students indicated most of their prior understanding came
from high school and/or TV sources. The post-test results improved, but some concepts continued to
be difficult for students, especially those relating to the structure of DNA. Student confidence in their
individual answers decreased on the post-test. Students found concept maps and traditional lectures
as the most helpful teaching strategies.

Dissemination Activities & Plans to Disseminate: This research was presented at the American
Society for Microbiology Missouri Branch meeting in April, 2009 and the ASM Conference for Under-
graduate Educators in May, 2009. An article is currently being prepared with planned submission in
the Journal for Microbiology & Biology Education.

Impacts of Project or Anticipated Impact: Understanding what misconceptions students have, the
sources of those misconceptions and which misconceptions are hardest to overcome will help me and
other educators develop teaching tools to target these troublesome areas. I have already started as-
sessing individual tools (concept maps, critical thinking exercises, analogies, etc.) and am continuing
to develop and assess other learning strategies to tackle the most difficult concepts and connections.

Challenges: Researching one’s teaching takes planning, takes time, and can be potentially hazardous
to the ego. In order to deal with these challenges, I used help from my colleagues. They reviewed my
materials and strategies, helping me identify possible pitfalls. To adjust to the additional demands on
my time, I dedicated set periods of time to focus on designing my research project and assessing the
data. Also to save time, I interviewed small numbers of students, scored essay-style questionnaires
from a subset of the class (instead of the entire class) and polled entire classes using computer-
scored, multiple-choice questions.
**Poster #132**  
**Category:** B1  
**Primary Project or Approach:** Assessment (Concept Inventories, critical thinking, other)  
**Institution:** Virginia Tech  
**Presenter:** Ann Stevens  
**Email:** ams@vt.edu  
**Co-Presenter:** A. L. Buikema, Jr., J. A. Evans, M. V. Lipscomb, and R. A. Walker, Virginia Tech  
**Field of Interest within Biology:** Cross-subdiscipline assessment

**Goals & Intended Outcome:** During the 2007-2008 academic year, departments across the Virginia Tech campus were charged with creating formal academic assessment plan strategies to comply with the Southern Association of Colleges and Schools (SACS) requirements for accreditation. The Department of Biological Sciences developed plans for its B.S., M.S. and Ph.D. programs; this presentation focuses on the assessment strategies for undergraduate students.

**Methods & Strategies:** Six learning outcomes were defined in the areas of (1) The Scientific Method, (2) Data Presentation and Analysis, (3) Evolution and Biological Diversity, (4) Genetics, (5) Cell and Molecular Biology and (6) Ecology.

**Evaluation Methods & Results:** To begin the assessment process, a 50 question on-line multiple choice test has been utilized to ascertain the background knowledge of entering freshman and the retained knowledge of graduating students. To date, the test has been given three times with equally high average test scores of freshman vs. seniors on the first two learning outcomes, but with significant increases in the test scores for seniors in the other four.

**Dissemination Activities & Plans to Disseminate:** This presentation is the first off-campus dissemination of this information.

**Impacts of Project or Anticipated Impact:** Thus, early indications are that a sample group of graduating seniors has achieved the desired levels of achievement in key learning outcome areas.

**Challenges:** There are more than 1500 undergraduate majors and ~40 teaching faculty and instructors in the department. All Biological Sciences majors must complete six semester-long core courses, which are taken primarily during the freshman and sophomore years, and the content of these courses served as the focus for development and assessment of student learning outcomes.

**Abstract:** The Path Towards Successful Programmatic Academic Assessment in Biological Sciences During the 2007-2008 academic year, departments across the Virginia Tech campus were charged with creating formal academic assessment plan strategies to comply with the Southern Association of Colleges and Schools (SACS) requirements for accreditation. The Department of Biological Sciences developed plans for its B.S., M.S. and Ph.D. programs; this presentation focuses on the assessment strategies for undergraduate students.

There are more than 1500 undergraduate majors and ~40 teaching faculty and instructors in the department. All Biological Sciences majors must complete six semester-long core courses, which are taken primarily during the freshman and sophomore years, and the content of these courses served as the focus for development and assessment of student learning outcomes. Six learning outcomes were defined in the areas of (1) The Scientific Method, (2) Data Presentation and Analysis, (3) Evolution and Biological Diversity, (4) Genetics, (5) Cell and Molecular Biology and (6) Ecology. To begin the assessment process, a 50 question on-line multiple choice test has been utilized to ascertain the background knowledge of entering freshman and the retained knowledge of graduating students.
To date, the test has been given three times with equally high average test scores of freshman vs. seniors on the first two learning outcomes, but with significant increases in the test scores for seniors in the other four. Thus, early indications are that a sample group of graduating seniors has achieved the desired levels of achievement in key learning outcome areas.

Poster #133
Category: B2
Primary Project or Approach: Determining key concepts and competencies
Institution: Howard Hughes Medical Institute
Presenter: William Galey
Email: galeyw@hhmi.org
Field of Interest within Biology: General Biology

Goals & Intended Outcome: The Association of American Medical Colleges (AAMC) and the Howard Hughes Medical Institute (HHMI) formed a partnership to examine the natural science competencies that a graduating physician needs to practice science-based medicine.

Methods & Strategies: The committee members, representing undergraduate, basic biomedical and clinical science faculty from across the United States, recommends a fundamental change from required science courses to mastered competencies.

Evaluation Methods & Results: A report from this committee was issued on June 5, 2009 and distributed broadly to undergraduate educators as well as medical faculty. It was the subject of an editorial in the June 5th issue of Science magazine. The committee members are now planning presentations and symposia at conferences in '09-10.

Dissemination Activities & Plans to Disseminate: The report has been distributed to all health professions advisors, medical schools, biology instructors at 2-year institutions, and colleges and university with substantial pre-medical interest.

Impacts of Project or Anticipated Impact: The committee suggests that this fundamental change from required science courses to mastered competencies could encourage the development of innovative and interdisciplinary science curricula, maintain scientific rigor of undergraduate science education, and encourage premed students to pursue a liberal education.

Challenges: The major challenges to this approach are yet to come. If the recommendations are followed, the change will have an impact on how courses in biology and chemistry are delivered to pre-medical and other students.

Abstract: A new report, issued June 5, 2009 by an expert committee convened by the Association of American Medical Colleges (AAMC) and the Howard Hughes Medical Institute (HHMI), defined for the first time the scientific competencies for future medical school graduates and for undergraduate students entering medical school. The committee members representing undergraduate, basic biomedical and clinical science faculty from across the United States, met five times to develop its recommendations.

The report, "Scientific Foundations for Future Physicians," recommends that medical and premedical education evolve from a static listing of courses to a dynamic set of competencies. The committee suggests that this fundamental change from required science courses to mastered competencies could encourage the development of innovative and interdisciplinary science curricula, maintain scientific rigor of undergraduate science education, and encourage premed students to pursue a liberal educa-
Poster #134
Category: B2
Primary Project or Approach: Determining key concepts and competencies
Institution: Michigan State University
Presenter: Charles Anderson
Email: andya@msu.edu
Co-Presenter: Laurel Hartley, University of Colorado, Denver
Brook Wilke, Michigan State University
Field of Interest within Biology: Ecology and Environmental Biology

Abstract: Are college students prepared to understand ecosystem carbon cycling? - Why it’s important and how principled reasoning can help

Reasoning about ecological systems requires students and citizens to understand complex relationships among processes (e.g. photosynthesis, respiration) across multiple scales (atomic/molecular, cellular, organismal, ecosystem). We developed assessments to investigate students’ ability to trace matter and energy through processes that generate, transform and oxidize organic carbon at multiple scales. Data from science majors in introductory biology courses at two large state institutions revealed that, students often used overly simplified gas-gas cycles (e.g. linking photosynthesis and respiration through the “oxygen-carbon dioxide cycle”) and overly simplified solid-solid cycles (e.g. linking decomposition and plant growth through soil nutrients). They often saw processes happening at large scales as distinct from the same processes occurring at smaller scales (e.g. forest primary production and cellular photosynthesis), and they consistently used energy as a “fudge factor” when they weren’t able to trace matter. Underlying these problems were difficulties with fundamental principles, including an atomic-molecular understanding of processes and conservation of matter and energy. These data pinpoint a “hidden curriculum” of content so familiar to biologists that they are hardly aware they use it and thus assume to also be understood by students, but that is not understood by students.

Poster #135
Category: B2
Primary Project or Approach: Determining key concepts and competencies
Institution: Washington University in St. Louis
Presenter: Thomas Woolsey
Email: woolseyt@wusm.wustl.edu
Co-Presenter: Lawrence Salkoff, Washington University in St. Louis
Aguan Wei, Washington University in St. Louis
Field of Interest within Biology: Neuroscience

Goals & Intended Outcome: Give students rigorous but interesting exposure to the key aspects of the function, development of the nervous system. Make certain that they fell comfortable in the principal areas of instruction. The students should first and foremost be "educated." Second we seek to attract them to careers that are related to understanding the nervous system and improving its function in health and disease.
Methods & Strategies: Lectures with interactive demonstrations and discourse. Problem sets and work sheets that force thinking and analysis. Active and semi-independent teaching in discussion sections by talented graduate student teaching assistants.

Evaluation Methods & Results: In the decade of teaching this course enrollment at the university has not increased but enrollment in the course has more than trebled. Performance on examinations has remained excellent (and in some cases seems to exceed that of more advanced students in graduate/MD programs). Cross listing of the course and its requirement for several programs in different departments and schools of the University suggest that a) students have learned and can used "complex" information; and b) this information is valuable for progress in different areas of science. We plan to follow up on these evaluations using models developed in other programs at the University. In particular we wish to track careers of students for whom we have provided recommendations for graduate education.

Dissemination Activities & Plans to Disseminate: There are no formal dissemination efforts although the class web site is widely accessible. This course provides valuable feedback on published materials and books which are available commercially.

Impacts of Project or Anticipated Impact: We know anecdotally that many of the students in this course go on to pursue careers in science and medicine. We have not developed good ways to distinguish between attraction, reinforcement, and/or discouragement. These issues are not supported by the university and while interesting are beyond the scope of our commitment to this teaching effort.

Challenges: There are issues with a diverse group of students psychology to engineering all getting on similar paths early in the course. TA's have been significantly effective in getting students to grasp all of the central points of the course. We also have had to work hard to get TAs with different backgrounds and interests that are not necessarily in Neuroscience comfortable with this field. In the end all have performed well and several have become "converts."

Abstract: Principles of the Nervous System: Undergraduates Taught By Medical School Faculty

Principles of the Nervous System (Bio 3411) is an upper level undergraduate course offered at Washington University in St. Louis by faculty from the School of Medicine. The course selectively considers: biophysics and physiology of neural activity; embryology and early development of the nervous system; brain anatomy and functional organization; and, the relation of all of these to each other and brain disorders. First taught by W. Maxwell Cowan and Dale Purves in the early ’70’s, Bio 3411 was a key component for creating the Division of Biological and Biomedical Sciences (DBBS) that integrated graduate education and scientific collaboration across Washington University. (DBBS enrolls about 600 graduate students each year in nearly 30 different departments.)

We (the fourth team to teach this course) have collaborated for the past decade. During that time, content, presentation, and support have all evolved substantially, and dynamically. The current curriculum, teaching styles and graduate student participation will be detailed. Several aspects illustrated include: focused coverage of selected topics; independent TA's lead group sessions to review and discuss concepts and facts; interactive lecture settings; shifts to web based resources; and interactions/cross listings in the university that include biology, psychology and engineering; enrollment and other changing components. Bio 3411 has become the exemplar for cross-university collaboration for other inter-campus/faculty instructional efforts in the biological and biomedical sciences at Washington University.
Poster #136
Category: B2
Primary Project or Approach: Determining key concepts and competencies
Institution: Xavier University of Louisiana
Presenter: Mary Carmichael
Email: mccarmic@xula.edu
Co-Presenter: Michelle Boissiere, Deidre Labat, and Shubha Kale Ireland, Xavier University of Louisiana
Field of Interest within Biology: General Biology

Goals & Intended Outcome: 1) Improve student learning of the fundamental Biology concepts so that they are ready to take the upper level Biology courses 2) Improve student engagement, application of knowledge learned, academic performance and retention. 3) Produce better prepared graduates to enter the bioscience fields.

Methods & Strategies: i) Detailed review and revision of course content and test-banks of the two sequential courses which are pre-requisites for all other Biology courses, ii) Development of new modules, instructors’ guides and student notes, iii) Introduction of personal response units for increased student engagement, iv) Expansion of the existing tutoring center to accommodate mandatory attendance of lower-performing students and v) Implementation of newer advising techniques to better track and remediate individual student’s specific academic challenges.

Evaluation Methods & Results: 1) Mid-semester student performance. 2) Final grade analyses. 3) Detailed tracking of students’ academic progress. 4) Data analysis of the personal response units’ feasibility study. 4) Tutoring Center survey analyses to determine the approaches that work well with students and to identify additional needs.

Dissemination Activities & Plans to Disseminate: 1) Periodic presentations to the faculty and internal advisory committee. 2) Submission of the formal yearly progress reports to the funding agency (Louisiana Board of Regents). 3) Presentation of data at the present conference sponsored by the AAAS and the NSF.

Impacts of Project or Anticipated Impact: In two short years since the start of this funded project, the approaches described above have produced a noticeable improvement in the mid-semester performance of students from an average of 40% passing to now more than 50% passing. Overall class GPAs are also showing a positive trend. These results are highly encouraging because they are based on data points obtained from over 800 students enrolled in these courses for each academic year and lay the foundation for further studies.

Challenges: None so far except perhaps that we had more time that we could devote to the various activities of the project.

Abstract: Xavier Biothrust 21: Rebounding from hurricane Katrina and producing a better prepared 21st century biosciences workforce for Louisiana

Xavier University of Louisiana, an HBCU (Historically Black Colleges and Universities) based in New Orleans, is nationally renowned for its undergraduate curriculum and success in the STEM departments, in particular its pre-medical program. However, it has been noticed in recent years that entering freshmen are less and less prepared for college level work. This has had a negative impact on completing the course syllabi and the ability to introduce newer concepts in the highly coordinated freshmen level courses. The extreme devastation caused by hurricane Katrina in 2005 exacerbated these universal challenges, since student enrollment and demographics were adversely affected. Combined,
these factors form the basis of a multi-year, multi-faceted pedagogical initiative in the Biology department of Xavier University to improve student learning, engagement, retention and overall success.

The ultimate goal of this initiative therefore is to increase the number of graduates who are well prepared and ready to contribute to the growing needs of the biosciences sector in Louisiana. Currently in its second year, this project utilizes various approaches to accomplish this goal. These include: i) Detailed review and revision of course content and test-banks of the two sequential courses which are prerequisites for all other Biology courses, ii) Development of new modules, instructors’ guides and student notes, iii) Introduction of personal response units for increased student engagement, iv) Expansion of the existing tutoring center to accommodate mandatory attendance of lower-performing students and v) Implementation of newer advising techniques to better track and remediate individual students’ specific academic challenges.

In two short years, these combined approaches have produced a noticeable improvement in the mid-semester performance of students from an average of 40% passing to now more than 50% passing. Overall class GPAs are also showing a positive trend. These results are highly encouraging because they are based on data points obtained from over 800 students enrolled in these courses for each academic year and lay the foundation for further studies.

Supported by the Louisiana Board of Regents, PKSFI Program (P.I.: S. K. Ireland)

**Poster #137**

**Category:** B3

**Primary Project or Approach:** Quantitative and Computational Biology

**Institution:** Appalachian State University

**Presenter:** René Salinas

**Email:** salinasra@appstate.edu

**Co-Presenter:** Eric Marland, Appalachian State University

**Field of Interest within Biology:** Ecology and Environmental Biology

**Goals & Intended Outcome:** Our goal is to prepare undergraduate students for careers in research biology, particularly in areas that require significant quantitative proficiency.

**Methods & Strategies:** We have developed a track within the mathematics major that focuses on the life sciences.

**Evaluation Methods & Results:** We have just started this new program of study and will be monitoring it closely. We will be keeping track of acceptance and success in graduate school programs, hiring and retention in industry, and student presentations and publications. We will also obtain feedback from faculty in the life sciences on the success of the students in their biological coursework.

**Dissemination Activities & Plans to Disseminate:** We plan to support students in this program in presenting their research and discuss the results of the program with faculty at other institutions at national meetings.

**Impacts of Project or Anticipated Impact:** We hope this new program of study can provide a template for institutions to attract and train quantitatively strong students in the biological sciences.

**Challenges:** Implementing new programs is always slow and tedious. We have been hoping to begin a companion program in the biology department, but interest there is somewhat less than in the mathematics department. We believe it will happen in time, but may take several years.
Abstract: Does The Best Preparation for a Biology Career Start in a Mathematics Department?

With the increase in mathematical and computational approaches in almost every biological field, what is the best way to train future researchers in biology? Perhaps some of the best training can be provided in a mathematics department. We have created a BS degree in Mathematics with a Life Sciences concentration that includes a strong background in chemistry and extensive depth in biology. While we see additional biology courses or a double major as ideal, we feel that the program provides a strong preparation for graduate studies (in both biology and mathematics programs) or professional work in mathematical or computational areas of biology.

Poster #138
Category: B3
Primary Project or Approach: Quantitative and Computational Biology
Institution: Carnegie Mellon University
Presenter: Russell Schwartz
Email: russells@andrew.cmu.edu
Field of Interest within Biology: Bioinformatics

Goals & Intended Outcome: Computational/statistical methods have become essential components of modern biology but are only gradually entering the training of future biologists. We aim to develop coursework to teach general biology students the key theory and tools without adding excessive new requirements to an already heavy course load.

Methods & Strategies: We are implementing a new computational biology class to specifically serve the general biologist. We have prototyped the material and strategies in a small, half-semester class focused on genomics. We now intend to scale up to a full-semester class planned as a requirement for all biological sciences majors.

Evaluation Methods & Results: Evaluation is accomplished largely within our new class, using homework assignments to determine whether students have developed the intended competencies. Our focus is on practical, hands-on training. Evaluation is therefore centered on hypothetical mini-research projects in which a student must select appropriate methodologies and tools, apply them, and correctly interpret their results. Secondary evaluation will focus on follow-up with later instructors and research advisors to validate that students maintain these competencies and can apply them in subsequent coursework and research practice.

Dissemination Activities & Plans to Disseminate: Because of the early stage of our efforts, dissemination has so far been limited, aimed at presenting our plans at meetings devoted to biology and bioinformatics education. As we validate our approaches, we intend to make successful course material available online to interested educators.

Impacts of Project or Anticipated Impact: In the near term, we expect students to be able to make use of computational competency in undergraduate research, increasing the pool of projects for which they are qualified, reducing their in-lab training time, and in some cases allowing them to introduce new techniques into their host laboratories. We also expect to enable other instructors to introduce additional quantitative material throughout the undergraduate biology curriculum. In the longer term, we expect graduates to be able to apply their computational training in graduate research or post-graduation employment.

Challenges: Our greatest challenge is the highly heterogeneous student population in need of computational biology education, including general biologists, computational biology specialists, non-
majors doing biology-related work, and various pools of graduate students. Even with new materials for the general biologist allowing us to better focus that for the computational biologist, it is a challenge to provide enough material at appropriate levels for all of the students. We have thus developed various ways of sharing material between different courses to better balance student needs with available instructor time.

**Poster #139**
**Category:** B3
**Primary Project or Approach:** Quantitative and Computational Biology
**Institution:** Florida International University
**Presenter:** Ophelia Weeks
**Email:** weekso@fiu.edu
**Co-Presenter:** Philip Stoddard and Thomas Pitzer, Florida International University
**Field of Interest within Biology:** Integrative Biology

**Goals & Intended Outcome:** Students finishing the QBIC program will have the skills needed to move fluidly among conceptual, analytical and quantitative approaches to solving biological problems.

**Evaluation Methods & Results:** We have several approaches to evaluation that are formative and summative.

**Dissemination Activities & Plans to Disseminate:** Information about QBIC is being disseminated through seminars; e.g., a Nov 24, 2008 seminar about QBIC at MIT Biology Department HHMI Seminar Series, and seminars at other institutions are being planned; symposia; e.g., planned symposium November 19, 2009 at the Florida Education Research Association Annual Meeting in Orlando, Florida, and symposia at other national conferences are being considered; publications, e.g. a planned 2009 submission to SCIENCE Education Forum or Cell Biology Education Journal, and future publications will be submitted when we generate more evaluative data; poster presentations, e.g. the conference on *Transforming Undergraduate Education in Biology: Mobilizing the Community for Change* in Washington DC.

**Impacts of Project or Anticipated Impact:** Reformed QBIC biology courses have already strongly influenced the biology curriculum for the general student body courses. Almost all investigative and exploratory modules have been or are in the process of being integrated. The influence of the QBIC curriculum is very invasive throughout the general biology program.

**Poster #140**
**Category:** B3
**Primary Project or Approach:** Quantitative and Computational Biology
**Institution:** Hunter College of CUNY
**Presenter:** Shirley Raps
**Email:** raps@genectr.hunter.cuny.edu
**Co-Presenter:** Derrick Brazill, Hunter College of CUNY
**Field of Interest within Biology:** Bioinformatics

**Goals & Intended Outcome:** The goal is to train undergraduates in quantitative biology. The outcomes we expect are that these students will be better prepared to go on to careers in biology.

**Methods & Strategies:** A number of courses are being developed in bioinformatics/quantitative biology. Quantitative biology modules are being created for all biology major core courses and for students
taking general biology. A summer workshop is being developed for students interested in learning about bioinformatics.

**Evaluation Methods & Results:** Evaluation methods include increasing the number of undergraduates interested in bioinformatics, increasing the number of students who graduate with a concentration in bioinformatics, and tracking students after graduation. So far, 4 biology majors, 2 computer science majors and 1 math major have graduated with concentrations in bioinformatics. Of the biology majors, one is going to medical school, one to graduate school, and one is working for an informatics company.

**Dissemination Activities & Plans to Disseminate:** Dissemination is carried out through brochures, speaking at college open houses for high school students, and a slide-show on bioinformatics during registration. The website for the program is http://darwin.hunter.cuny.edu/HHMI-Supplement/bioinfor-workshop.html

**Impacts of Project or Anticipated Impact:** As a minority institution, our anticipated impact is to increase the number of our undergraduates who go on to current/future careers in quantitative biology.

**Challenges:** A major challenge initially was getting funding agencies to support our efforts. The college was very supportive and Prof. Weigang Qiu, who developed this program, was given released time to do so. Eventually, the NIH MARC Phase II program provided funds to support the program and HHMI is providing funds for the bioinformatics summer workshop to be given for the first time this summer.

**Abstract:** With the advent of genomics and proteomics, biology is evolving from a purely experimental science performed at the bench to one in which large databases of information, statistical methods and computer models play a significant role. In order to effectively extract, model and analyze this enormous amount of data, various computational tools and statistical models are becoming increasingly necessary in biomedical research. Working effectively to build these complex systems requires collaboration with a multidisciplinary team of research scientists. Therefore, in both academic and industry research, there is a strong need for scientists who are equipped with computational and mathematical skills as well as with chemical and biological knowledge.

To address this need, Hunter College, funded by a grant from The Howard Hughes Medical Institute and an NIH MARC supplement, has introduced Bioinformatics into its science curriculum in two ways. First, working together, the departments of Biological Sciences, Chemistry, Computer Science, and Mathematics and Statistics each created separate concentrations for their majors in Bioinformatics. This required the creation of new courses designed specifically for these concentrations. Thus, students interested in academic or industrial careers in Bioinformatics can get the experience and training they require to excel in the field. Second, these departments have created modules within their existing courses to introduce Bioinformatics to all of their majors as well as the college as a whole. Thus, students who will not necessarily pursue Bioinformatics will be familiar with many of its concepts and applications. Here we present some of the curricula developed for this undertaking.
Co-Presenter: Catherine Mader, Hope College
Field of Interest within Biology: Biophysics

Goals & Intended Outcome: The goal of this project was to provide undergraduate students with opportunities to increase interdisciplinary learning while helping them develop the ability to deal with complex problems and to communicate across disciplines through the use of investigative, interdisciplinary case studies.

Methods & Strategies: We developed interdisciplinary minors and courses and utilized interdisciplinary investigative case studies in our introductory science courses. We held workshops for faculty to help them learn about and develop these case studies.

Evaluation Methods & Results: A variety of assessment methods were used, including having faculty report on their experiences, evaluating student work in interdisciplinary areas, and having students complete self evaluation of learning gains instruments. We learned that interdisciplinary work may be more difficult for faculty than for students, that students did as well in interdisciplinary areas as in disciplinary areas and that students reported gains in confidence in approaching problems from multiple perspectives and in the ability to communicate outside their disciplines.

Dissemination Activities & Plans to Disseminate: We have reported on the program and the interdisciplinary case studies at several conferences, and have published papers on two of the case studies, on the development of an interdisciplinary minor, and on interdisciplinary research programs. We plan to publish additional case studies as time allows.

Impacts of Project or Anticipated Impact: Faculty at Hope College have become more aware of the educational and research benefits of interdisciplinary approaches and now are able to develop interdisciplinary case studies, laboratory activities, and other educational activities. Faculty have learned that interdisciplinary work requires a commitment of considerable time and a willingness to work through communication difficulties. Students have developed a greater appreciation of interdisciplinary approaches and the ability to better communicate across disciplines.

Challenges: The barriers to communication across disciplines and the differences in approaches to doing science of the faculty were greater than we had anticipated. The time required for the development of interdisciplinary activities was also greater than we anticipated. We thus needed to be patient as we worked on those activities. We did not fully anticipate the percentage of faculty who were not interested in becoming involved in interdisciplinary research or education and needed to move forward with our program with only partial buy-in by STEM faculty.

Abstract: Enhancing Student Learning at the Interface of Biology and Physics with an Interdisciplinary Case Study on Vision

Solving biological and biomedical problems increasingly requires an interdisciplinary approach. Thus as undergraduates become the physicians and research scientists of the future, they will need to be prepared to work as members of interdisciplinary teams. One approach to providing undergraduates with interdisciplinary experiences is to incorporate interdisciplinary case studies in science courses. At Hope College, one such case study is on the physics of vision. In an introductory biology class, students use optical benches to explore the physics of pinholes, mirrors and lenses in order to compare the focusing systems of the nautilus, scallop and human. Students then work in teams to make recommendations on ways in which color range, visual acuity or light sensitivity can be enhanced using a biological approach. Following the completion of the case study project, students demonstrated a good understanding of the physics and biology of vision. In addition, students reported significant gains in confidence in their ability and willingness to approach problems from more than one scientific perspective, in their awareness of the complexity of scientific problems, and in their appreciation of the importance
of physics in understanding biological functions. Interdisciplinary case studies have the potential to help better prepare students for science based careers but require a substantial time investment by faculty and a willingness to work outside of one’s area of training. Supported by a grant to Hope College from the Howard Hughes Medical Institute through the Undergraduate Science Education Program.

Poster #142
Category: B4
Primary Project or Approach: Transdisciplinary concerns including fundamentals and prerequisites related to other subjects: (chemistry, physics, earth subjects, mathematics)
Institution: Smith College
Presenter: Margaret Anderson
Email: manderso@smith.edu
Field of Interest within Biology: Biology within the natural sciences

Goals & Intended Outcome: The Natural Sciences Planning Committee (NSPC) recognizes that the life sciences at Smith College are part of a larger interdependent entity of natural sciences. Our goals include encouraging students to learn across disciplines and to teach skills that promote interweaving cross-disciplinary knowledge.

Methods & Strategies: Our strategies are to (1) identify and implement interdepartmental mechanisms to ensure students' solid grounding across the natural sciences and (2) identify and diminish barriers between departments and programs to allow fluid sharing of resources and expertise.

Evaluation Methods & Results: We used two preliminary approaches to illustrate cross-disciplinary interrelatedness. First, we organized a series of keynote presentations on "The Ecology of Disease" (2008-09: this topic encompassed biomedical studies, studies of global populations and human behavior, mathematical analyses of the spread of disease, and historical investigations of disease propagation); in 2009-10, we will have and a "Darwin Symposium." Second, we initiated discussions with departments about holding a science center-wide "festival" of senior honors research presentations.

Dissemination Activities & Plans to Disseminate: Initial dissemination about the formation of the NSPC in Spring 2008 was posted internally on the College's Dean of the Faculty website. Future dissemination will be based on outcomes of planned interdisciplinary curricular initiatives.

Impacts of Project or Anticipated Impact: Goals we anticipate to achieve in the near future include (1) streamlining interdisciplinary research opportunities for students across departments and programs in the natural sciences; (2) developing interdisciplinary courses within the natural sciences that will encourage inquisitive and skeptical thinking and the ability to participate in substantive discussions about evidence; (3) developing mechanisms for sharing faculty expertise across departments.

Challenges: Not unexpectedly, we discovered the challenges posed to interdisciplinary endeavors by the historical organization of the academy into isolated, independent departmental structures. We expect incremental changes initially and aspire to broader changes in the long term. An unexpected reward of our conversations has been the creative energies generated by the exchange of ideas and affirmation of our common goals.
Poster #143
Category: B4
Primary Project or Approach: Transdisciplinary concerns including fundamentals and prerequisites related to other subjects: (chemistry, physics, earth subjects, mathematics)
Institution: Truman State University
Presenter: Jason Miller
Email: millerj@truman.edu
Field of Interest within Biology: Mathematical Biology and Biomathematics

Goals & Intended Outcome: Our goal is to prepare undergraduate students in biology (and in mathematics) to work at the intersection on the life and mathematical sciences. Successful students go on to pursue interdisciplinary graduate work or secure employment in positions that require interdisciplinary ability.

Methods & Strategies: Students (and faculty) are trained to work at the intersection of the life and mathematical science by conducting a year-long research project as a member of a cross-disciplinary team that consists of two faculty (one each from mathematics and biology) and two students (one each from mathematics and biology). Four such teams work on different projects and together form a learning community.

Evaluation Methods & Results: We evaluate our program by tracking students after graduation. Approximately 80%+ of our students go on to an interdisciplinary graduate programs or secure employment that takes advantage of the interdisciplinary training. We also evaluate the 10-week, intensive summer research portion of our program using an electronic journal and the SURE II survey. These assessment instruments illuminate the learning trajectory of students as they learn to work in an interdisciplinary way (the e-journal) and they show us how they grew professionally, socially, and intellectually as a result of the summer experience (SURE II).

Dissemination Activities & Plans to Disseminate: We report results of our program each year at the annual meeting of the Society for Mathematical Biology and the Joint Mathematics Meeting. Faculty involved in the program also deliver posters on the program at various professional meetings throughout the year.

Impacts of Project or Anticipated Impact: The research-focused training program has led to the development of an innovative, interdisciplinary minor in mathematical biology. Students pursuing this minor develop a portfolio of work to demonstrate their ability to do interdisciplinary work. We also have a handful of interdisciplinary courses to serve this minor, including Introduction to Mathematical Biology, Biostatistics, Bioinformatics, and an Introduction to Computer Programming.

Challenges: While faculty have been very supportive of the program, the institution’s administrative structure is not adapted to support an inter-departmental program like ours. Faculty have taken on this challenge and are working with a new Dean and department Chairs to create new administrative mechanisms. Attracting students to the interdisciplinary courses also proved to be challenging at first, but enrollment has grown as the new (and challenging) courses have proved to be interesting and valuable, and as students have seen that our program’s students are very competitive in the competition of graduate programs and jobs.

Abstract: Training Undergraduates in Mathematical Biology Using Research With Faculty.

Since 2004, Truman State University has trained students to conduct interdisciplinary research in mathematical biology through a combination of research experiences with faculty collaborators,
courses, and field trips. This program of experiences for undergraduates has been made possible by the National Science Foundation’s Interdisciplinary Training for Undergraduates in Biology and Mathematics (UBM) program. This poster will outline our courses and our research program (including a portfolio-based interdisciplinary minor in mathematical biology), what we have learned about assessing interdisciplinary learning, and the role field trips have played in the professional development of faculty and students.

Poster #144
Category: B4
Primary Project or Approach: Transdisciplinary concerns including fundamentals and prerequisites related to other subjects: (chemistry, physics, earth subjects, mathematics)
Institution: University of Maryland
Presenter: Kaci Thompson
Email: kaci@umd.edu
Co-Presenter: Todd Cooke, University of Maryland
Joelle Presson, University of Maryland
Field of Interest within Biology: General Biology
Goals & Intended Outcome: We seek to enhance interdisciplinary training and quantitative skills in all biology students.

Methods & Strategies: We are using a team-based approach involving large numbers of faculty across different departments and even extending to nearby community colleges. Their efforts are guided by the 2003 NRC report "Bio2010" and more recent reports urging more interdisciplinary training for biology students. Their efforts are supported by our newly established Chemical and Life Sciences teaching and Learning Center.

Evaluation Methods & Results: Individual courses are using pre- ad post-tests of student learning and qualitative assessments of perceived learning gains and changes in attitudes. These are being supplemented with graduation surveys to identify long term shifts in student attitudes and longitudinal monitoring of student success in advanced coursework.

Dissemination Activities & Plans to Disseminate: Outcomes are being disseminated in peer-reviewed publications (e.g., Journal of College Science Teaching) and through presentations at teaching and learning conferences. Many curricular materials are being broadly disseminated online.

Impacts of Project or Anticipated Impact: This systematic effort to revise fundamental science courses required of all biology students has impacted thousands of students. We expect that students will gain a greater appreciation for the need for broad, interdisciplinary training and will show enhanced problem solving skills. Preliminary data analysis indicates a shift in student appreciation for the importance of mathematics in modern biological sciences.

Challenges: Faculty are committed to enhancing the curriculum, but have little formal training in teaching and learning, which has slowed our progress. We have attempted to address these challenges by establishing a Teaching and Learning Center to support these efforts and provide professional development opportunities for graduate students and faculty involved in curriculum development efforts.

Abstract: Interdisciplinary Curriculum Reform in the Biological Sciences

A major curriculum redesign effort at the University of Maryland (UM) has brought together teams of faculty, postdoctoral fellows and graduate students to infuse all levels of our undergraduate biological
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sciences curriculum with current research approaches, increased emphasis on interdisciplinary connections, increased mastery of quantitative applications, and increased emphasis on conceptual learning and active-engagement pedagogy. Our efforts have largely been guided by the recommendations in the NRC report BIO 2010 (2003), and are in alignment with the more recent recommendations from the Association of American Medical College’s Scientific Foundations for Future Physicians (2009). To date, these efforts have involved over 80 faculty from two community colleges and seven UM departments, plus five postdoctoral fellows, 28 graduate students, and 10 undergraduates, and have resulted in revisions to courses in biology, biochemistry, chemistry, mathematics and physics serving biological sciences students. A partial list of the projects includes:

- How organisms work: Biology as an integrative science
- Calculus for life sciences
- Mathbench: Infusing math into fundamental biology courses
- Biological analytical chemistry: A context-based approach to analytical chemistry
- Bridging the gap: Physics for biology students
- Increasing community college student success: A collaboration between UM and community college faculty

These efforts have been funded in part by grants from the Howard Hughes Medical Institute Undergraduate Science Education Program, the National Science Foundation and the University of Maryland Center for Teaching Excellence.

Poster #145
Category: B4
Primary Project or Approach: Transdisciplinary concerns including fundamentals and prerequisites related to other subjects: (chemistry, physics, earth subjects, mathematics)
Institution: University of Massachusetts Boston
Presenter: Brian White
Email: brian.white@umb.edu
Field of Interest within Biology: Interdisciplinary

Goals & Intended Outcome: To show students the connections between key disciplines of modern biology: evolution, molecular biology, biochemistry, and genetics.

Methods & Strategies: I have developed an interactive simulation, Aipotu. Aipotu is an interactive computer simulation that allows students to explore a biological phenomenon - the color of simulated flowers - using tools from the major disciplines of modern biology.

Evaluation Methods & Results: Examining students' work (lab reports, blogs, etc) and videotape of students in lab.

Dissemination Activities & Plans to Disseminate: Publication in education journals and presentations at conferences.

Impacts of Project or Anticipated Impact: Helping students to connect these disciplines.

Challenges: None so far.

Abstract: Aipotu is an interactive computer simulation that allows students to explore a biological phenomenon - the color of simulated flowers - using tools from the major disciplines of modern biology. In Genetics, students determine the inheritance of color by choosing flowers to cross and observ-
ing the offspring generated by the simulation. In Biochemistry, students edit protein sequences that are folded by the simulation in order to elucidate the relationship between protein structure and color. In Molecular Biology, students edit DNA sequences that are expressed by the simulation in order to observe the connection between DNA and protein. In Evolution, students subject a field of flowers to random mutation at the DNA level and natural selection to observe evolution in action. Flowers generated by evolution can then be examined using the other three tools to determine the specific molecular events that led to particular evolutionary changes. Because all of these tools can be applied to the same phenomenon, students will see how these four perspectives form a united biological view of life. The underlying 'biological engine' can be adapted to simulate a wide range of phenomena including, morphology, gene regulation, and multi-genic traits.

Poster #146
Category: B4
Primary Project or Approach: Transdisciplinary concerns including fundamentals and prerequisites related to other subjects: (chemistry, physics, earth subjects, mathematics)
Institution: University of Oregon
Presenter: Karen Sprague
Email: kus@uoregon.edu
Field of Interest within Biology: Molecular Biology & Biochemistry

Goals & Intended Outcome: The goal is to focus the introductory biology sequence on key biological principles, emphasizing the chemistry and physics on which they depend, integrating the reasoning by which they were discovered, and showing their power to explain a wide range of interesting biological phenomena.

Methods & Strategies: A year of general chemistry is a prerequisite, and many problems are designed to require students to apply chemical principles (e.g. dissociation of weak acids, oxidation) in biological settings (e.g. hemoglobin's affinity for O2 as a function of pH). Labs and lectures are tightly linked, conceptually & temporally.

Evaluation Methods & Results: Students are asked to solve problems they haven't seen before, but that are based on the principles they've been learning. Such problems are included in regular exams (along with less challenging questions), in lab exercises, and in extra-credit problems based on recent discoveries and news items. Students who do well on problems of this kind invariably thrive in more advanced courses and in medical or graduate school. Their average MCAT or DAT biology scores regularly exceed those of students who've taken more typical introductory biology courses.

Dissemination Activities & Plans to Disseminate: When our introductory lab exercises were redesigned to minimize mechanical data collection and encourage analysis and deduction, they were presented at a national meeting on science education (PKAL?).

Impacts of Project or Anticipated Impact: Alumni credit later success to the way they learned to think about Biology in Foundations, and frequently comment on how unusual and effective their preparation is compared to that of their post-graduate peers.

Challenges: The biggest challenge is encouraging students to put in the necessary effort to work problems they haven't been led through in advance. Most of their previous experience in science courses, particularly high school biology, has been memorization of facts, structures and vocabulary. They've had little practice in reasoning from principles, and often lack the patience to try. If they can develop the capacity and enthusiasm for working at a problem whose solution isn't immediately obvious, the rest is comparatively easy.
Poster #147  
Category: B4  
**Primary Project or Approach:** Transdisciplinary concerns including fundamentals and prerequisites related to other subjects: (chemistry, physics, earth subjects, mathematics)  
**Institution:** University of Richmond  
**Presenter:** Ovidiu Lipan  
**Email:** olipan@richmond.edu  
**Field of Interest within Biology:** Biophysics  

**Goals & Intended Outcome:** The goal of the UBM project as well as the IQS course is to increase the number of students who will pursue scientific careers that effectively integrate the mathematical and biological sciences.  

**Methods & Strategies:** We believe that the route for a mathematically-oriented person to get into biology is to be immersed in a wet lab environment as soon as possible; only after that can they be immersed into “Cookbook Style” biology.  

**Evaluation Methods & Results:** 1) I follow my biology-oriented research student’s career from freshmen to graduate school and beyond and observe if they use mathematical approaches in their study of biological systems or not. 2) I follow my mathematically oriented research student’s career from freshmen to graduate school and beyond and observe if they work on biological systems or not. If the group (1) uses mathematics and group (2) works on biological systems, and if they are happy, I assess that my initial work in attracted them towards quantitative approaches or biology or was successful.  

**Dissemination Activities & Plans to Disseminate:** I plan to use my wet-dry laboratory for bio-math interdisciplinary research studies. I plan to teach and continue to develop the Integrated Quantitative Science that integrates material taught in the first semester in each of biology, chemistry, physics, mathematics, and computer science.  

**Impacts of Project or Anticipated Impact:** I anticipate convincing physics and mathematics undergraduates that biology is a fascinating filed for research where their quantitative skills will prove useful.  

**Challenges:** Did not encounter any unexpected challenges.  

**Abstract:** The poster will focus on two biology-oriented interdisciplinary activities at University of Richmond. One project is related to the NSF-funded project on Interdisciplinary Training for Undergraduates in Biological and Mathematical Sciences (UBM). The other project is related to the HHMI-funded award that supports the creation of a “supercourse” [Integrated Quantitative Science IQS] that integrates material taught in the first semester in each of biology, chemistry, physics, mathematics, and computer science. The course will be offered for the first time in Fall 2009. The goal of the UBM project as well as the IQS course is to increase the number of students who will pursue scientific careers that effectively integrate the mathematical and biological sciences.  

The UBM research and training activities are based on the existing quantitative biology laboratory of Ovidiu Lipan, designed as a hybrid between a wet (Biology) and a dry (Mathematics and Physics) laboratory. Students working in this lab are trained to use mathematical models in the early stages experimental design.  

The IQS course, limited to first year students, is a 2-semester course counting for 2 units each semester, half of what a student takes in each semester. A student who completes both semesters can go on to
take the second course in any of biology, chemistry, physics, mathematics, or computer science. The course will be team taught by 5 faculty each semester, one from each discipline. The material is integrated and it is organized by theme. IQS 1: Drug Resistance; IQS 2: Cell signaling.

Poster #148
Category: C1
Primary Project or Approach: Faculty Development
Institution: Brigham Young University
Presenter: William Bradshaw
Email: william Bradshaw@byu.edu
Co-Presenter: Jennifer Nelson, Kathryn B. Groneman, and John D. Bell, Brigham Young University
Field of Interest within Biology: Cell Biology

Goals & Intended Outcome: Improve the ability of teachers to help their students acquire analytical thinking skills

Methods & Strategies: Repeated use of formal formative assessment exercises ("embedded-in-the-curriculum") in the classroom, reducing classroom lecturing in favor of active learning inquiry exercises, fostering improved out-of-class study strategies by employing Elaborative Questioning interactions between classmates

Evaluation Methods & Results: Student performance on examination tasks requiring analysis of experimental data was elevated in semesters in which the new pedagogy was employed compared to control semesters using conventional methods. Measures of student affect were improved as a result of the new course design and management. There is a relationship between performance on analytical thinking tasks and students' self-identified learning style; those with an "innovators" perspective have a advantage over self-styled "implementors."

Dissemination Activities & Plans to Disseminate: Our pedagogical and assessment methods have been disseminated to colleagues at collaborating universities through the auspices of funds obtained from the U.S. Department of Education (FIPSE).

Impacts of Project or Anticipated Impact: Significant gains have been achieved in biology courses taught by colleagues in our dissemination project (item 5). A number of faculty colleagues at our own school are experimenting with these methods.

Challenges: There is resistance by some students to changes in their traditional routines (exams based on short-term memorization, passive participation in teacher lectures, etc.). Most students, however, respond very positively to the innovations, because they experience real improvement in learning.

Abstract: Personal and Attitudinal Predictors of Performance on Analytical Reasoning Tasks in Cell Biology: Helping Students Improve their Study Methods

Efforts to improve college science teaching might properly have a dual focus: to enlarge the objectives of a course to include the development of analytical reasoning skills, and to adopt a classroom pedagogy that promotes active participation. Faculty implementing such reforms will observe, however, that some students find it difficult to adjust to a non-traditional course design. The move away from listening to a professor talk for 60 minutes and from exams based primarily on short-term memory is discomforting because it demands a new set of learning strategies for which students may not prepared.
We report here our efforts over several years to define the attributes of problems that require cell biology students to interpret experimental data and identify the scholastic attributes of those students who deal with such problems successfully. The accumulated data include measures of student affect, self-efficacy, meta-cognition, and study methods that might serve as diagnostic indicators capable of predicting performance.

The goal of this investigation is to enable teachers to provide specific direction throughout the semester that will enable individuals to make corrections in their study procedures that will result in improvement on exams. We suggest that teachers not only have an opportunity to instruct in the fundamentals of a discipline and promote the associated thinking skills, but also to work at the epistemological level in assisting students to learn how to learn more effectively.

Poster #149
Category: C1
Primary Project or Approach: Faculty Development
Institution: National Association of Biology Teachers
Presenter: John Moore
Email: jhmoore@taylor.edu
Co-Presenter: Todd Carter and Marion Jascot, National Association of Biology Teachers
Field of Interest within Biology: Faculty Professional Development

Abstract: The National Association of Biology Teachers primary focus is life science education. NABT empowers educators to provide the best possible biology and life science education for all students. NABT accomplishes these goals by participation and partnerships with other biological societies and educational outreach organizations to provide professional development in undergraduate biology education. Currently, NATB has developed guidelines on undergraduate biology education. Recognizes and delivers thirteen categories of awards for outstanding teaching in biology and in biology education research. NABT produces a high quality refereed journal on biology education, which provides current pedagogy and new ideas and techniques. The annual conference provides for undergraduate professional development for faculty.

To recognize excellence in undergraduate biology education, NABT has established Two-Year Biology Teaching Award, the Ron Mardigian Biotechnology Teaching Award, the Four-Year College & University Biology Teaching Award, the Four-Year College & University Biology Research in Teaching Award, the Excellence in Encouraging Equity Award, the Evolution Education Award and the Distinguished Service Award.

The American Biology Teacher is an outstanding refereed journal on biology education. Articles provide to assistance to educators on pedagogy, “how-to-do-it”, “Quick Fixes”, and current educational research and biology research in “Inquiry & Investigations”. NABT annually invites outstanding biologists and biology educators to participate in professional development for undergraduate faculty. The annual professional development conference provides opportunities for educators to interact and network with outstanding biology faculty and learn innovative ways of teaching biology.

NABT has highly active two-year and four-year sections that promote excellence in biology education which survey undergraduate faculty and assess for quality improvement of NABT’s services in meeting the needs of undergraduate biology education. Outreach to a variety of local, state and national organizations for the sake of biology education; BioClubs, BioBlog, Facebook connections, Stem Cell Education Summit on Regeneration Biology with partner (GPI Genetics Policy Institute), promotion of the
Human Origins Project with the National Museum of Natural History/Smithsonian Institution and other projects may be positive examples of what we are trying to do. The participation of NABT in Regional Workshops, Affiliate workshops and presentations at state/province science teachers’ conferences/conventions has brought NABT’s participation on to undergraduate campuses.

The major difficulty in all that NABT attempts are in the communicating/networking effectively through virtual mechanisms is a challenge. Thus being able to partner with societies, linking to their virtual and non-virtual resources, capitalizing on each other’s conferences/workshops facilitates our combined missions and visions.

Poster #150
Category: C1
Primary Project or Approach: Faculty Development
Institution: The American Society of Human Genetics
Presenter: Michael Dougherty
Email: mdougherty@ashg.org
Co-Presenter: Angie Wong, ASHG
Field of Interest within Biology: Genetics

Goals & Intended Outcome: To leverage a professional society’s influence to transform undergraduate and K-12 genetics education through partnerships between university and high school faculty; to improve the reward system in higher education (e.g., tenure and promotion) so that it encourages undergraduate teaching and outreach education.

Methods & Strategies: The Geneticist-Educator Network of Alliances (GENA) project pairs geneticists with high school biology teachers, who develop and implement lesson plans that represent best practices. The pair co-presents the lessons in the high school classroom and assesses student learning. ASHG uses these experiences as levers points for changing higher ed.

Evaluation Methods & Results: Through internal and external evaluation processes, ASHG has reviewed the quality of lesson plans produced, ascertained participant knowledge of pedagogy and content, tracked expectations and intended outcomes of participants over time, determined project-related changes in practice, and evaluated whether the GENA project has changed ASHG vis-a-vis its support for K-12 science education outreach. Moreover, the project is tracking the effect that its support for faculty outreach is having on the tenure and promotion of participating geneticists.

Dissemination Activities & Plans to Disseminate: The project has a Web site describing its work and disseminating lesson plans (and is also active on NSF’s MSPnet), and it has been summarized in published articles ranging from Genetic Engineering News to local newspapers in cities where GENA partnerships are located. Several abstracts for presentation have been accepted for science education meetings later this year, and several partnerships are writing paper for peer-reviewed publications. At least one lesson plan has been commercialized.

Impacts of Project or Anticipated Impact: Many of the ostensibly one-year partnerships (of 70 total) have continued into second and third years, demonstrating that the intensive collaborative work of geneticists with teachers has led to long-term relationships. Undergraduate faculty become more aware of good pedagogy and bring that knowledge back to their own classrooms. Even more importantly, ASHG has become much more deeply committed to undergraduate teaching through its participation in the GENA project and has established several new initiatives as a result, such as an undergraduate internship program, a genetics-education research grants program, and a new infrastructure to support faculty use of K-12 outreach for tenure and promotion.
Challenges: The project had some logistical challenges such as changes in project leadership, which were not anticipated, but these resulted in no substantive changes in the project. However, the project altered its final-year objectives (with consent of NSF) in response to what it had learned during years one and two in order to better accomplish the goals related to professional-society influence and the reward structure of higher ed. For instance, it convened a group of experts to consider what steps beyond faculty-teacher partnerships would best leverage change in K-12 outreach, and some of what ASHG has done is being adopted by other scientific professional societies.

Poster #151
Category: C1
Primary Project or Approach: Faculty Development
Institution: University of Wisconsin-Madison
Presenter: Teri Balser
Email: tcbalser@wisc.edu
Field of Interest within Biology: Biology Education

Goals & Intended Outcome: The Institute for Cross-college Biology Education (ICBE) was created to administer the Biology major, and to provide a centralizing and coordinating force for our students and faculty/staff. Our goals are to foster collaboration and innovation in biology education at all levels and create lifelong learners.

Methods & Strategies: We will approach our goals by building community among faculty and doing faculty development as well as by developing and assessing a set of embedded learning outcomes for our undergraduate Introductory curriculum. We are also developing an innovative approach to advising the undergraduate major.

Evaluation Methods & Results: We will evaluate our success based on number of participants in our programs, verbal and written feedback, exit surveys for students, and by developing instruments to assess student learning in Introductory Biology.

Dissemination Activities & Plans to Disseminate: We are hoping that the programs we develop for advising and TA training can be used in other areas on campus.

Impacts of Project or Anticipated Impact: We anticipate that a successful Institute will result in higher success rates for graduating students, TAs with skills useful for future faculty, and faculty who are more willing to adopt innovative classroom practices.

Challenges: Cross-college politics and territory battles have been an unexpected challenge, as has the economy and the often traditional attitude and resistance to change of our more senior faculty members.

Poster #152
Category: C2
Primary Project or Approach: Developing Materials to Support Undergraduate Education in Biology
Institution: American Physiological Society
Presenter: Marsha Matyas
Email: mmatyas@the-aps.org
Co-Presenter: Thomas A. Pressley, Texas Tech University Health Sciences Center
Field of Interest within Biology: Physiology & Anatomy
Goals & Intended Outcome: The APS Archive of Teaching Resources is a free digital library that facilitates colleague-to-colleague sharing. The Archive is a collaborative library with resources cataloged by APS and a growing list of scientific organization partners (Human Anatomy and Physiology Society (HAPS), Society for Developmental Biology (SDB), and National Association for Health and Science Education Programs (NAHSEP)).

Methods & Strategies: All materials have been peer reviewed for scientific accuracy and the appropriate use of humans/animals. Partners catalogue resources developed by their society (articles, teaching units, research summaries, etc.). Individuals submit teaching resources they have developed (lesson plans/labs, digital presentations, graphics, rubrics, etc.). The Archive is open to searches through online search engines (e.g., Google), the BEN portal (www.biosciednet.org) and the National Science Digital Library (www.nsdl.org). The Archive offers users powerful search and browse tools. Users do not have to be registered to use the Archive. However, registered users have personalized “My Archive” area that retains previous functions (saving searches, saving resources to folders, sharing of folders) while also providing a listing of users’ submissions and allowing users to track their submissions through the review process.

Evaluation Methods & Results: Measures of the Archive’s impact include rates of submission by societies and individuals, resources accessed and downloaded, and new user registrations as well as use of new browse features and highlighted resources (featured items, research “bytes,” historical item links, and news items). Statistics are compiled monthly and, starting in 2009, an annual survey of users will be conducted.

Dissemination Activities & Plans to Disseminate: The Archive is promoted via exhibits, poster presentations, email listservs, and meeting sessions. For example, listings of related Archive resources are prepared for faculty development sessions such as the Experimental Biology meeting Physiology Refresher Course and the HAPS Institutes for Undergraduate Physiology Faculty.

Impacts of Project or Anticipated Impact: The Archive has nearly 2,500 peer-reviewed teaching resources (education articles, lesson plans, PowerPoint, video, podcasts, graphics, etc.) and more than 5,800 registered users. In the first six months of 2009, users discovered more than 7 million items through search and browse functions. Users viewed more than 63,000 individual resource descriptions and, after viewing the resource description, they downloaded more than 30,000 resources. That is, 49% of the time, users who viewed an item description went on the view/download the teaching resource.

Challenges: While users are very interested in getting teaching resources from the Archive, only a small percentage are interested in submitting items, despite the fact that they receive at least three expert reviews of their resource and continue to hold copyright for the resource. A new set of community-building tools has been proposed for funding to help build the community of users and contributors.

Poster #153
Category: C2
Primary Project or Approach: Developing Materials to Support Undergraduate Education in Biology
Institution: Austin Community College
Presenter: Alice Sessions
Email: asession@austincc.edu
Field of Interest within Biology: Physiology & Anatomy
Goals & Intended Outcome: The online self-studies of biological concepts is designed to help students prepare for and succeed in Anatomy and Physiology courses.

Methods & Strategies: Each of the 2 self-study units are divided into modules which contain narrated PowerPoint lectures, concept checks and test questions with answers. Some self-study modules also have enrichment activities. The self-studies are housed at the college's Biology homepage and are free and accessible to all.

Evaluation Methods & Results: An assessment test of general biology concepts is required of all students prior to enrolling in Human Anatomy. Before the self-study, 30% students failed with scores below 50/100; after introducing the self-study, the failure rate dropped to 16%. The students getting a score of 51-70 stayed constant at 46-48%. There was an increase in the number of students receiving an assessment test score of greater than 70 from 27% to 38% after starting the self-study. There has also been an increase in the Anatomy grades as a result of the self-study.

Dissemination Activities & Plans to Disseminate: Internally, there are links from the Biology homepage Anatomy and Physiology site; flyers to students, counselors and advisors. Externally, I presented the online self-study at NISOD in May 2009.

Impacts of Project or Anticipated Impact: Students are able to submit an anonymous feedback form. Over 91% of the 174 responses received thus far have been positive. In addition, faculty teaching the target anatomy and physiology courses as well as faculty teaching general biology, genetics and microbiology, recommend the online self-study modules to their students as enrichment and review.

Challenges: We anticipated challenges in obtaining permission to include copyrighted photographs, tables and activities in the self-study. However, nearly everyone we approached gave permission.

Poster #154
Category: C2
Primary Project or Approach: Developing Materials to Support Undergraduate Education in Biology
Institution: Iowa State University
Presenter: Diane Bassham
Email: bassham@iastate.edu
Co-Presenter: Eve Syrkin Wurtele, David Kabala, and William Schneller, Iowa State University
Field of Interest within Biology: Cell Biology

Goals & Intended Outcome: Our aims are (1) Expand the educational content of the Meta!Blast module (2) Integrate characters, music, plot and assessment components (3) Perform iterative assessment

Methods & Strategies: We will develop Meta!Blast, an interactive module on cell biology. Students will be immersed in a three-dimensional, biologically accurate plant cell. Individual biological concepts will be parsed into student tasks, while keeping these tasks in the context of the whole environment.

Evaluation Methods & Results: Meta!Blast will be subject to external formative and summative evaluations by target audiences from Iowa and New Mexico and the results used to drive changes to the module.

Dissemination Activities & Plans to Disseminate: All material will be freely available for download from the project web site.
Impacts of Project or Anticipated Impact: We anticipate that the project will impact biology education at both the high school and introductory college level. The overarching hypothesis of this project is that interactive, dynamic learning environments can facilitate student learning of complex biological concepts.

Challenges: None as yet.

Abstract: The overarching hypothesis of this project is that interactive, dynamic learning environments can facilitate student learning of complex biological concepts. To address this hypothesis, we will develop Meta!Blast, an interactive module on cell biology. Students will be immersed in a three-dimensional, biologically accurate plant cell. Individual biological concepts will be parsed into student tasks, while keeping these tasks in the context of the whole environment. Meta!Blast will combine sophisticated simulation technology with accurate biological information, to allow students to explore and interact with a cell and during this process to discover cellular energetics, gene function, cellular defenses against pathogens, and the consequences of compartmentation. The ability to change environmental scales can make the student aware of not only the individual parts and processes in the cell but how they work together to allow the whole to function.

Poster #155
Category: C2
Primary Project or Approach: Developing Materials to Support Undergraduate Education in Biology
Institution: Penn State
Presenter: Denise Woodward
Email: dmw29@psu.edu
Field of Interest within Biology: General Biology

Goals & Intended Outcome: A goal of this project is to develop and assess the effectiveness of interactive animations for use in an introductory biology class. While there are many excellent animations available to illustrate biological phenomena, few animations exist that allow user interactivity. We have also developed accompanying still images.

Methods & Strategies: Interactive animations are being produced using Flash. These animations allow users to modify inputs and outputs of biological processes. Currently, these animations are delivered to students within a series of online tutorials that accompany our introductory majors biology course.

Evaluation Methods & Results: A study of the effectiveness of an interactive animation was integrated into the class as a graded activity. Two of the lab groups used an interactive version of the animation and the other two lab groups used a non-interactive version of the animation. Students worked through the animation in pairs. Each student was given a 9-item pretest and a 13-item posttest that were answered individually. Both of the groups showed significant improvement on the posttest while a comparison of posttest scores indicated that neither group performed significantly better than the other on the posttest.

Dissemination Activities & Plans to Disseminate: The still images and animations that have been developed as part of this project are available through the Penn State Biology department web site (http://www.bio.psu.edu/people/faculty/woodward/). They are available for use and dissemination.

Impacts of Project or Anticipated Impact: The anticipated impact of this project is the development of a series of coordinated images and animations that educators can use to teach challenging
concepts in introductory biology. Also, the assessment activities will help to provide insight into the effectiveness of animations as a learning tool.

**Challenges:** The biggest challenge I faced was finding programmers with sufficient Flash experience to develop interactive animations. I have lost several programmers and have had to find replacements.

**Poster #156**  
**Category: C2**  
**Primary Project or Approach:** Developing Materials to Support Undergraduate Education in Biology  
**Institution:** Society for Developmental Biology  
**Presenter:** Diana Darnell  
**Email:** darnell@email.arizona.edu  
**Field of Interest within Biology:** Developmental Biology

**Goals & Intended Outcome:** Scientists and science teachers are constantly creating resources aimed at more effectively teaching both old and new concepts. The BiosciEdNet (BEN) collaborative aims to collect, peer review and share these teaching resources. As a partner in BEN, the Society for Developmental Biology curates, annotates, reviews and archives learning resources in the field of developmental biology.

**Methods & Strategies:** To become efficient providers of peer-reviewed educational resources, we partnered with the American Physiological Society (APS), one of the initial BEN partner societies. SDB uses the cataloging, submission, review and archiving processes developed by APS. Our partnering and mentoring relationship gave LEADER a huge boost toward successful participation in the BEN archive.

**Evaluation Methods & Results:** APS and partners have collaborated to upgrade our software for the archiving of metadata and resources. The new archive includes analysis software that tracks use. SDB has collected 302 resources, which have been viewed 8942 (metadata) and 3734 (URL) times, respectively. In 103 cases the resource was downloaded. Now that basic use tracking is possible, we are working to discover what types of resources people are looking for and to get feedback on the usefulness of the resources we are providing.

**Dissemination Activities & Plans to Disseminate:** The SDB part of the archive, LEADER (Library of Educational Annotated Developmental biology Resources) has been presented to faculty through email, and in workshops, poster sessions and booths at Regional, National and International SDB meetings. Outreach to K-12 teachers is proposed.

**Impacts of Project or Anticipated Impact:** The impact of LEADER and BEN in general should be to get high-quality, pedagogically appropriate learning resources into the hands of teachers and students. Our database should move tested practice and current science content from the hands of those who created it into the hands of others who can use it so we don’t have to keep reinventing the wheel. This should save time and raise the quality of both pedagogy and content in our classrooms.

**Challenges:** The largest challenge we faced was getting the software rebuilt to meet the expanding needs of the partnering societies. Our original software designers did not deliver as expected and this caused our efforts to stall for almost 2 years. Now that we are moving again with a new software designer, the largest challenge is to get people to take the time to contribute resources, and to think to search our database as they are creating their teaching materials. Because our offerings are still limited, one is more likely not to find what one is looking for, than to find it. It is the classic Catch-22 of
need participation to get comprehensive content and needing comprehensive content to get participation.

Abstract: LEADER Abstract for DC09 - Teaching includes identifying appropriate content resources and creating, managing and assessing effective opportunities for others to manipulate and integrate that content into their understanding of reality. Scientists and science teachers are constantly creating resources aimed at more effectively teaching both old and new concepts to their students. The BioSciEdNet (BEN) collaborative aims to collect, peer review and share these teaching resources along with ideas about effective ways to use them. BEN is currently an aggregation of 37 scientific and professional societies/groups that have banded together to coordinate peer-review and archiving of diverse educational resources. The BEN collaborators share one database and metadata construct, making all of the contributed materials searchable in a common website (http://www.biosciednet.org/portal/). Educators, researchers, students and the public can search and access teaching resources for developmental biology or the other disciplines represented in BEN by going to the BEN portal and following the instructions.

A wide variety of educational resources are included: animations, charts, dictionaries, exams, fieldtrip guides, lab exercises, lectures, lesson plans, movies, simulations, syllabi and many more. Because of its inclusivity, in 2005, the BEN Collaborative was selected to be the National Science Digital Library (NSDL.org) Pathway for Biological Sciences Education. One of the BEN collaborators is the Society for Developmental Biology (SDB).

Our contribution to the larger BEN archive is called LEADER, the Library of Educational Annotated Developmental biology Resources. LEADER is a collection of educational resources created by faculty to enhance the learning of developmental biology by students at all levels of their education. Our challenge is to collect, annotate, post and link together useful learning resources with enough information attached to allow people to find them and use them effectively. To become efficient providers of peer-reviewed educational resources, we partnered with the American Physiological Society (APS), one of the initial BEN partner societies. SDB uses the cataloguing, submission and review processes developed by APS.

Our partnering and mentoring relationship gave LEADER a huge boost toward successful participation in the BEN archive. LEADER is a product of the Professional Development and Education committee of SDB, is supported by a grant from the National Science Foundation (NSF) and is administered by the American Association for the Advancement of Science (AAAS).
the site aims to encourage instructors to adapt their pedagogy in small ways, en route to more transformative change.

**Evaluation Methods & Results:** Evaluations (beginning in August 2009) will focus on two sets of outcomes: (a) instructor use and learning, and (b) student learning and attitudes. Thirty teachers will participate in a 6-hr workshop on site resources and then implement selected materials in their classrooms. Teachers will be pre- and post-tested on their knowledge and teaching motivation regarding the nature of science. Students in these classrooms will be pre- and post-tested on knowledge of the nature of science, attitudes toward science, and science content. Feedback from teachers on the materials will also be obtained.

**Dissemination Activities & Plans to Disseminate:** The project has been presented through talks and posters at many professional meetings (e.g., SICB, Evolution, NABT, NSTA) and at several professional development in services. It will be featured in an upcoming article in the American Journal of Botany. Our teacher ambassador program launches this summer.

**Impacts of Project or Anticipated Impact:** Despite only a recent launch, the site already receives 35,000 page requests per month and has a subscriber base of more than 400. In addition, key elements of the site have been incorporated into the upcoming edition of the popular Miller and Levine high school biology text. Through ongoing dissemination efforts and collaborations, we expect to see Understanding Science materials implemented in many hundreds of classrooms nationwide. We anticipate that this will result in an increased emphasis on teaching the nature and process of science and scientific reasoning skills in these classrooms.

**Challenges:** Understanding Science’s design and content were guided by an active advisory board of 35 individuals from 24 institutions and 13 states, including scientists and faculty from multiple disciplines, cognitive psychologists, philosophers of science, educational researchers, teachers, and web experts. Developing content that would accurately reflect such diverse perspectives on what science is and how science works was a significant challenge, but one that the team managed through a shared commitment to the project’s goals and respect for the needs of teachers.

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**Poster #158**  
**Category:** C2  
**Primary Project or Approach:** Developing Materials to Support Undergraduate Education in Biology  
**Institution:** Utah State University  
**Presenter:** Greg Podgorski  
**Email:** podgorski@biology.usu.edu  
**Co-Presenter:** John Jeon, Utah State University  
Joel Gardner, Utah State University  
Thayne Sweeten, Utah State University  
**Field of Interest within Biology:** General Biology  

**Goals & Intended Outcome:** To deepen understanding of relationships between biological facts and concepts through the use of concept maps.  

**Methods & Strategies:** The use of standard and resource-rich concept maps presented in an online environment.  

**Evaluation Methods & Results:** General biology students were provided the opportunity to work with either standard or resource-rich concept maps covering facts and ideas in gene expression. Students were given a pre-test, a post-test, and a post-post-test. Normalized pre-test/post-test and pre-
test/post-post-test learning gains were scored for a control group and the groups working with either the standard or resource-rich map. The group working with the standard concept map showed the greatest post-test and post-post-test gains. However, between group differences were not statistically significant.

Dissemination Activities & Plans to Disseminate:  The results were presented in posted form at a biology educator’s meeting in March, 2009.

Impacts of Project or Anticipated Impact:  The project motivated the investigators to explore new approaches to the use of concept maps, specifically to create online tools that will allow more interaction with the maps and the options for students to construct sections of the map rather than working with instructor-generated maps.

Challenges:  In an unsupervised online environment involving a large (approximately 500) and diverse group of participants, controlling for student motivation and effort is difficult. A partial though not perfect solution was to create filtering questions that assessed if students had worked with the maps at all prior to answering content-based assessment questions. We will explore additional options, including remotely monitoring the time and ways that students work with the map and more strongly encouraging students to spend time with the maps.

Abstract:  Do Concept Maps Help In Learning Biology?

Concept maps have been promoted as an effective tool to increase learning and develop higher-order thinking skills. However, few studies have rigorously examined the effectiveness of concept maps in teaching biology. We tested the hypothesis that concept maps would improve student learning of gene expression (transcription, RNA processing, translation) in a general biology class. Students were assigned randomly to three groups: a control group that did not use any concept map; a group that used a standard concept map; and a group that used a rich concept map. Intervention materials were available to students for a three day window. Students were assessed pre-, post-, and post-post-tests using sets of 15 multiple choice questions at the Bloom’s Revised Taxonomy levels of Remember and Understand.

We also assessed learning gains by analyzing responses to relevant questions on an hourly exam and the final exam. One hundred thirty-six students completed all parts of the study. The normalized learning gains for pre-/post-test performance were 27% (control group), 40% (standard concept map group) and 32% (rich concept map group). These differences, however, were not significant. This study will repeated with refinements in fall 2009.

Poster #159
Category: C3
Primary Project or Approach:  Research on How People Learn Biology
Institution:  Bates College
Presenter:  Pam Baker
Email:  pbaker@bates.edu
Field of Interest within Biology:  General Biology

Goals & Intended Outcome:  Learning and Teaching Biology: An Introductory Biology course for majors and non-majors in which students learn biology in order to teach it to high school students.

Methods & Strategies:  High School teachers identified the content areas they wanted taught. The college students were required to learn the principles, concepts and vocabulary of all of the selected topics. They then worked in groups to identify the appropriate content and the methods for teaching it to others.
**Evaluation Methods & Results:** College students took exams on the content areas and assessed each other's performance in the group. The high school teachers were asked to evaluate the college students' effectiveness and the learning of their high school students.

**Dissemination Activities & Plans to Disseminate:** Some aspects of this approach have been presented at the Education section of the American Society for Microbiology, and some have been published in Microbiology Education 5: 21-29.

**Impacts of Project or Anticipated Impact:** Many of the students were biology majors, or went on to become biology majors as a result of this course. Over the years several have gone on to become science teachers. Others have gone on to graduate school and report that this experience helped them become effective teaching assistants and to understand group dynamics and that people have different learning styles.

**Challenges:** Working with multiple high school teachers simultaneously takes a lot of time. The Harvard Center for Community Partnerships, Bates College Office of Service Learning, provided essential support in creating and maintaining the partnerships.

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**Poster #160**  
**Category: C3**

**Primary Project or Approach:** Research on How People Learn Biology  
**Institution:** University of Washington  
**Presenter:** M. Patricia Morse  
**Email:** mpmorse@u.washington.edu  
**Field of Interest within Biology:** Marine Biology

**Goals & Intended Outcome:** Describe the model and share the outcomes and benefits to students and faculty as seen in the Research Apprenticeship courses given at the Friday Harbor Laboratories.

**Methods & Strategies:** Student input in course evaluations, faculty input from interviews, reports from a questionnaire sent to former participants.

**Evaluation Methods & Results:** Evaluation is from course completions and later input from participants.

**Dissemination Activities & Plans to Disseminate:** These outcomes were discussed in a joint paper with Dr. Sara Hiebert, Swarthmore College at the Society of Integrative and Comparative Biology meeting in Boston, and at the International Society of Invertebrate Morphology meeting summer of 2008 in Copenhagen, Denmark.

**Impacts of Project or Anticipated Impact:** It is a collective project, not mine. The impact has been very encouraging, with many graduates entering professional post-graduate programs when completing their undergraduate studies.

**Challenges:** The biggest drawback is the expense, and I am part of a group that is continuing to raise funds from private donors and help match other grant funds.

**Abstract:** Exceptional Undergraduate Research Experiences at a Marine Laboratory.
The importance of research experiences is not new in undergraduate education, but the types of experiences have become more varied and meaningful for both the students and the faculty. Involving undergraduates in NSF grants to meet the “Broader Impacts” of the science, several NSF and Howard Hughes Medical Institute special grants that focus on undergraduates and the senior thesis courses at many colleges add meaningful research activities to the curriculum. Students are guided to ask their own questions and a faculty member often benefits from the undergraduate’s innovative ideas. Common characteristics of the learning environment are quality group interactions, adequate resources, technical and computational access and support, an encouraging mentoring environment and a shared passion of the combined researchers for the scientific work. Culminating presentations of the research results to department gatherings and at national discipline meetings add to the unique intensity of the research experience. Successful programs and the common factors in these interactions are discussed for two venues, Swarthmore College and the University of Washington Friday Harbor Marine Laboratories.

**Poster #161**

**Category: C4**

**Primary Project or Approach:** Promoting Institutional Change (Universities and colleges, departments, professional societies)

**Institution:** Michigan State University

**Presenter:** Tammy Long

**Email:** longta@msu.edu

**Co-Presenter:** Diane Ebert-May, Michigan State University
Sara Wyse, Michigan State University

**Field of Interest within Biology:** General Biology

**Goals & Intended Outcome:** We are applying principles of Backward Design to guide the restructure of introductory biology for majors. Our work will: 1) provide a testable model for course reform that can be implemented at other institutions, and 2) document long-term outcomes for students through their work in upper division courses.

**Methods & Strategies:** The reformed course encompassed: 1) derivation of learning goals that define the mission of the course, 2) infusion of active, learner-centered instruction that reflects scientific practice, 3) redesigning professional development for TAs to focus on pedagogical support, and 4) multiple assessments of student learning.

**Evaluation Methods & Results:** Course goals were derived from interviews with faculty teaching upper-division target courses, national calls for reforming science instruction, and university-wide goals for liberal learning. Reformed class meetings and labs incorporated evidence-based, learner-centered teaching strategies that actively engaged students in learning science content and processing skills. Assessments aligned with specific, measurable learning objectives provided instructors data about student learning that drove real-time instructional decisions. Long-term student outcomes will assess the overall impact of the reform.

**Dissemination Activities & Plans to Disseminate:** In order to maximize visibility to biology faculty and future faculty in the context of their research and professional development venues, we are disseminating findings through science journals, scientific meetings, and in local and national dissemination networks.

**Impacts of Project or Anticipated Impact:** Data derived from rigorous, repeatable studies about the effects of curricular reform on student outcomes, including long-term learning and retention in life science majors, will be broadly applicable. The project has provided a context for novel research on biology teaching and learning, including work by two postdoctoral scholars studying the impact of a
model-based pedagogy on scientific reasoning, and a Plant Biology graduate student who will earn her degree for work that explores the relationship between teacher beliefs and practice for graduate TAs in the context of reformed professional development.

**Poster #162**  
**Category: C4**  
**Primary Project or Approach:** Promoting Institutional Change (Universities and colleges, departments, professional societies)  
**Institution:** University of Oklahoma  
**Presenter:** Gordon Uno  
**Email:** guno@ou.edu  
**Co-Presenter:** Charlene D’Avanzo, Hampshire College, MA  
Todd Carter, Seward County Community College, KS  
Susan Musante, American Institute of Biological Sciences  
**Field of Interest within Biology:** General Biology  

**Goals & Intended Outcome:** The Introductory Biology Project (IBP), an NSF funded Research Coordination Network project, will articulate a shared vision of introductory biology courses to prepare biology students and will develop a collaborative network of individuals, projects, and societies actively engaged in the reform of undergraduate introductory biology education.

**Methods & Strategies:** The project will bring together scientists, science educators, biology instructors, and members of biological professional societies in a series of meetings over five years and through an online network to connect existing projects and stimulate the broad scale implementation of innovative ideas.

**Evaluation Methods & Results:** IBP evaluation will involve the analysis of data from online questionnaires given to undergraduate faculty from colleges and universities across the country to assess the network’s effectiveness in mobilizing faculty to improve biology teaching and learning. The IBP's planned website of resources and tools will be assessed by its use.

**Dissemination Activities & Plans to Disseminate:** The project received funding in February 2009 and a website is currently under development and plans are underway for sharing information at upcoming biology education meetings.

**Impacts of Project or Anticipated Impact:** IBP addresses issues of workforce preparedness, science literacy, and retention of students by focusing on the Introductory Biology experience. The project will transform courses from encyclopedic lists of facts into a rich array of experiences including the use of a thematic introduction to the study of life built around an evolutionary perspective and integrating current research opportunities across the curriculum. It will provide a strategy for helping faculty deal with the ever-increasing content of biology and for students to conduct authentic research, learn about careers related to biology, and improve their ability to apply their understanding of key biological concepts to novel situations.

**Challenges:** The project has not yet met any unexpected challenges.
Poster #163
Category: C5
Primary Project or Approach: Career Issues
Institution: SimBiotic Software
Presenter: Eli Meir
Email: eli@simbio.com
Field of Interest within Biology: Teaching software

Goals & Intended Outcome: To establish a place where independent authors can publish biology education software and other materials and receive income to sustain them.

Methods & Strategies: We are building an online marketplace for simulated biology labs. The marketplace will initially contain labs written by SimBiotic Software and our collaborators, but we will be expanding the capabilities to make it available for other authoring groups as well.

Evaluation Methods & Results: Like any good capitalist enterprise, the success of our marketplace will be determined by sales. We believe this is a good educational measure as it means the materials which instructors find most useful will receive the most revenue, and will therefore have the resources to give the best support and make frequent improvements. In addition, we plan to set up mechanisms to facilitate conducting educational assessments on each module, with the ability to collect anonymous pre and post test data.

Dissemination Activities & Plans to Disseminate: We will be advertising the system to biology professors around N. America.

Impacts of Project or Anticipated Impact: We expect hundreds of biology instructors around N. America to be using simulated labs from this system within 2 years, making it a good platform from which other authors can launch their own materials.

Challenges: Building such a system is quite challenging in time and resources, but this is to be expected.

Abstract: You Get What You Pay For The need for a marketplace for independent authors of biology teaching software -Dr. Eli Meir, SimBiotic Software

The National Science Foundation and others have recently been pushing for repositories of teaching materials to be available for free on the web. NSDL is the most prominent example, and an NSF-sponsored report on “cyberlearning” recommended NSF adopt policies that promote open, freely available educational resources.

In this poster I will argue that although “free” is seductive, it is a bad strategy for some types of educational materials, especially software and other materials that are expensive and need frequent updating. For those, we should use the power of capitalism to select and promote the best items and to provide funds for supporting them. However, right now there are no good options for smaller and independent authors of educational materials to publish and receive enough compensation for continued maintenance and improvements. What is needed is a marketplace for high-quality biology educational software. SimBiotic is developing such a marketplace and I will describe our plans for allowing independent authors to use it.
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Poster #172  
Category: A1  
**Primary Project or Approach:** Encouraging and Enabling Student Active Learning (Examples include Case Studies, POGIL, Clickers, Problem Based Learning)  
**Institution:** Auburn University  
**Presenter:** Sharon Roberts  
**Email:** robersr@auburn.edu  
**Field of Interest within Biology:** Immunology

**Goals & Intended Outcome:** The intended goal of the project is to help students improve their performance in immunology through the development of improved metacognitive and learning skills.

**Methods & Strategies:** I have developed optional assignments which provide various types of questions and approaches to the material which require them to move beyond simply reading their notes and memorizing facts. These questions encourage working with the material in a variety of ways and making connections throughout the semester.

**Evaluation Methods & Results:** The project is designed to determine whether completing these assignments improves student performance in the course. It is also designed to test whether student attitudes towards learning skills and metacognition change and whether they recognize the transferability of these skills to other courses.

**Dissemination Activities & Plans to Disseminate:** I have in the past participated in faculty development workshops and hope to do that with this project. I also intend to publish the results of the analysis of the project when the data has been analyzed.

**Impacts of Project or Anticipated Impact:** None as yet, but based on the outcome of the results of the project I intend to improve on the strategy and apply it to other courses. In particular, I hope as I improve on this strategy to encourage those faculty teaching introductory courses to try it.

**Challenges:** Because this is a new and different approach, some students have resisted trying a new way to learn. Also, many of them are quite comfortable and have been successful memorizing facts. This is a senior level course and so the impact of this new way of learning is encountered fairly late in their college career. I hope as I improve on this strategy to encourage those faculty teaching introductory courses to try it.

**Abstract:** Through fourteen years of teaching immunology to undergraduate students at Auburn University, I have come to believe that one of the critical differences between students who succeed in the course and those who don’t is often the student’s ability to develop strategies to work with the material. These cohorts of students differ less in their innate intelligence than in their metacognitive abilities. Like many biology subjects, immunology requires mastery of concepts and facts but it does not lend itself to problem sets or obvious ways for students to test themselves. The successful student has annotated their notes, incorporated images, added notes from the textbook and drawn their own pictures or summaries of the material. Struggling students are more likely no more engaged in the material than reading their notes over and over.

These students are frequently genuinely perplexed as to why they are not succeeding. One of the obstacles to reaching these students in a very large lecture course (approximately 200 students) is the lack of recitation time or graduate student teaching assistants. In an effort to help these students develop their metacognitive abilities and improve their performance in the course, I have developed assignments that provide questions that require the students to work with the material. The questions...
ADDITIONAL POSTER ABSTRACTS

 are designed to help students move from lower levels of knowledge to more sophisticated understanding. In addition, the purpose and design of the assignments is discussed with the class with the goal of having them see that these strategies for learning immunology transfer to learning in any subject. Details on the use of these assignments, sample questions and a research project to test their effectiveness will be presented in the poster.

Poster #197
Category: A1
Primary Project or Approach: Encouraging and Enabling Student Active Learning (Examples include Case Studies, POGIL, Clickers, Problem Based Learning)
Institution: BioQUEST Curriculum Consortium - Beloit College
Presenter: John R. Jungck
Email: jungck@beloit.edu
Field of Interest within Biology: Mathematical Biology

Goals & Intended Outcome: The BioQUEST Curriculum Consortium (http://bioquest.org) seeks to support national and international faculty development and curricular changes through workshops, online fora, development, adoption, adaptation, and vetting of quantitative problem solving and investigative case-based learning to help students actively learn long-term strategies of research, publication, and professional peer review.

Methods & Strategies: Four current projects highlight our efforts to include much more mathematics and computational analysis across the undergraduate biology curriculum: (1) NUMB3R5 COUNT (Numerical Undergraduate Mathematical Biology Education) -HHMI; (2) the Biological ESTEEM Project (Excel Simulations & Tools in Biology) -MAA; (3) BEDROCK (Bioinformatics) - NSF; and (4) SCOPE (scientific collaboratories)-NSF.

Evaluation Methods & Results: Faculty in workshops always fill out evaluations at the end of each workshop. Additional follow-ups are conducted via online surveys, blogs, phone interviews, and face-to-face interviews at professional meetings. We also make site visits to campuses and collaborate with local communities in curricular change and evaluation. All of simulations and tools are peer reviewed by many project participants during workshops and through use in their classroom. We and other scholars have published over a hundred articles in professional journals based on projects emanating from the BioQUEST Curriculum Consortium. We invest heavily in participating faculty's careers and believe that their appointment, re-appointment, tenure, promotion, grants, awards, etc. are testimony to the effectiveness of our investment in faculty.

Dissemination Activities & Plans to Disseminate: Two books out: (1) Microbes Count: Problem Posing, Problem Solving, and Peer Persuasion in Microbiology; edited by John R. Jungck, Marion Field Fass, and Ethel D. Stanley (ASM Press); (2) Biological Inquiry: A Workbook of Investigative Case Studies, 2/E, Margaret Waterman and Ethel Stanley (Benjamin Cummings). Huge web collection of resources: simulations, tools, cases, data sets (http://bioquest.org).

Impacts of Project or Anticipated Impact: Over five hundred colleges and universities have adopted and adapted BioQUEST modules and cases in their classrooms and labs. Over six thousand professors have participated in BioQUEST faculty development and workshops over the past 23+ years. Numerous faculty have received awards, tenure, promotion, and grants based on work with BioQUEST. Staff of the BioQUEST Curriculum Consortium have served as chairs of education committees of many professional and educational societies and have received national and international recognition for their activities. In addition, they serve on numerous policy boards, are frequent invited
speakers at professional scientific and educational societies' conferences, universities and colleges, and serve on editorial boards of a variety of journals.

**Challenges:** We expected enormous resistance to learner-centered, quantitative, collaborative, issue based pedagogies and curricular change and have received it. However, we were not prepared for the participation of so many research faculty who were frustrated with contemporary approaches such that they have been wonderful supporters and have laid down challenges to us to go beyond the first year of undergraduate education & to address the full spectrum of the undergraduate curriculum. This has spread us thin & required that we develop many new affiliations with professional societies with scientific expertise and an interest in educate to form partnerships with us. We were not prepared for the millions of visitors to our web site from all over the planet and the electronic expectations for rapid and informed response.

**Abstract:** With the extraordinary number of opportunities available to scientists with expertise in bioinformatics, geographic information systems, medical visualization, computational biology, and analysis of massive complex data sets and national policy reports like NRC’s *Bio 2010*, HHMI’s *Beyond Biology 101*, NSF’s document on the role of theory in biology, MAA’s *CRAFTY* reports and *Bio2010: Linking Undergraduate Disciplines*, and AAMC’s revisions announced this year, numerous institutions are beginning to develop more quantitative biological courses and curricula at both the undergraduate and graduate level.

In response to this challenge, the BioQUEST Curriculum Consortium (BioQUEST = Quality Undergraduate Educational Tools and Simulations in Biology), a twenty-three year old national curricular reform initiative, with NSF and HHMI funding in collaboration with EOT-PACI (Education, Outreach and Training – Partnership for Advanced Computing Infrastructure), has been developing problem solving approaches to quantitative areas across the spectrum of biology that stress the foundational importance of mathematics and evolutionary biology.

While many definitions for bioinformatics exist, Ming-Ying Leung and J. Aaron Cassill (NSF DUE EMD Award - #9981104) have defined bioinformatics as the “study [that] integrates mathematical and computational techniques with biological knowledge to extract, organize, and interpret information from a wealth of genetic sequence data obtained from various genome projects.”

This foregrounding of mathematics and computer science in bioinformatics education has meant either that students major in these two disciplines with a minimal exposure to biology or that students in biology take almost all of their cognate coursework in these two areas. Unfortunately, both types of existing programs have to date ignored any deep education in evolutionary biology.

BioQUEST has a long history of trying to help undergraduates learn long term strategies of research by working on open-ended problems with powerful professional tools with a consistent learner-centered pedagogical philosophy: problem posing, problem solving, and persuading peers.

In this case, we currently have five projects that emphasize faculty development in adopting and adapting as well as developing quantitative biological educational simulations, tools, and investigative cases for inclusion in their curricula:

1. **NUMB3R5 COUNT (Numerical Undergraduate Mathematical Biology Education)** (http://www.bioquest.org/numberscount/) - HHMI;
2. **The Biological ESTEEM Project (Excel Simulations and)** (http://www.bioquest.org/esteem/) - MAA & NSF;
3. **BEDROCK (Bioinformatics Education Dissemination ...)** (http://bioquest.org/bedrock/) - NSF;
(4) ICBL (Investigative Case Based Learning) (http://bioquest.org/icbl/) - NSF; and
(5) SCOPE (Supporting Scientific Collaboration Online ...) (http://bioquest.org/scope/) have combined
the use of a powerful bioinformatics packages, mathematical and statistical tools, large data sets,
simulations, modeling packages, and extensive online collaboration technologies to help faculty
adopt, adapt, develop, and share quantitative biology learning resources and strategies with one
another.

The BioQUEST Curriculum Consortium is funded through 2013 by several awards from the National
Science Foundation as well as grants from the Howard Hughes Medical Institute, the International
Union of Biological Sciences, the National Evolutionary Synthesis Center (NESCent), the National Institute
for Mathematical Biology Synthesis Center (NIMBioS), the Society for Mathematical Biology, the Bot-
any Society of America, the American Society for Microbiology, EOT-PACI (Education, Outreach and
Training – Partnership for Advanced Computing Infrastructure), and the Mathematics Association of
America.

**Poster #171**

**Category: A1**

**Primary Project or Approach:** Encouraging and Enabling Student Active Learning (Examples include
Case Studies, POGIL, Clickers, Problem Based Learning)

**Institution:** Encyclopedia of Life

**Presenter:** Jeff Holmes

**Email:** jholmes@eol.org

**Field of Interest within Biology:** Ecology and Environmental Biology

**Goals & Intended Outcome:** The Education and Outreach Group of the Encyclopedia of Life seeks to
increase knowledge and awareness of biodiversity issues around the world by engaging students in ac-
tive, participatory learning projects based on species pages in the Encyclopedia of Life.

**Methods & Strategies:** Undergraduate students in biology-related classes contribute to the Encyclo-
pedia of Life by building species pages for species that have not yet been completed. Deep under-
standing of a species and related biodiversity issues is promoted through this collaborative and moti-
vating process.

**Evaluation Methods & Results:** Evaluating the impact and effectiveness of this Undergraduate Ini-
tiative is accomplished through a variety of means including the successful publishing of species ac-
counts to the Encyclopedia of Life following a thorough review of content by an expert (often the in-
structor leading the course) and measures such as post-project interviews and surveys for both stu-
dents and course instructors.

**Dissemination Activities & Plans to Disseminate:** Dissemination plans include outreach efforts
such as talks at education conferences, publications, and web-based materials to promote the initiative
as a learning activity that connects students directly to authentic science and the creation of an inter-
national resource for biologists and the public alike.

**Impacts of Project or Anticipated Impact:** The undergraduate initiative was successfully piloted in
2008, receiving very positive reviews by both students and course instructors. Students appreciated
the opportunity to contribute to real science and felt that the project was motivating and a valuable
use of their time. Instructors were impressed by the level of effort put in by their students and noted
that the work promoted scientific skills development such as reviewing relevant literature, analyzing
data and weighing evidence.
**Poster #176**  
**Category: A1**  
**Primary Project or Approach:** Encouraging and Enabling Student Active Learning (Examples include Case Studies, POGIL, Clickers, Problem Based Learning)  
**Institution:** Ohio State University  
**Presenter:** Steve Rissing  
**Email:** rissing.2@osu.edu  
**Field of Interest within Biology:** General Biology

**Goals & Intended Outcome:** I have tried to design a non-majors GEC introductory biology sequence incorporating best pedagogical practices including inquiry, learning cycles (in laboratories/recitations and then in lecture), cooperative learning, and case studies (in the second course). The sequence explicitly aligns with state K-12 science content standards and aims to increase scientific literacy of college graduates; the sole required ‘text’ is the daily New York Times.

**Methods & Strategies:** All major new concepts are introduced in small group laboratory (BIO 101) or discussion (BIO 102) sessions and then, and only then, developed further with real-life applications in lecture sessions. An ongoing and extensive GTA and UTA training program permits close coordination between the discovery phase of each topic (laboratory/recitation) and analysis and application (lecture of up to 700 students.)

**Evaluation Methods & Results:** OSU’s Center for Life Sciences Education has developed, validated and administered an end-of-term ‘Student Assessment of Learning Gains’ survey instrument keyed to the stated learning objectives of each course. More detailed assessments of specific exercises, especially one examining misconceptions associated with intelligent design creationism through a student led ‘History of Disease’ exercise, suggest we are meeting some of our objectives with these courses.

**Dissemination Activities & Plans to Disseminate:** We have had significant success disseminating the approach and philosophy of these courses to almost all other instructors and sections of all BIO 101 and 102 courses at OSU. We have published our first experimental analysis of the effect of our approach. We have not been able to secure funding for broader scale assessment and dissemination of our efforts.

**Impacts of Project or Anticipated Impact:** We have instilled a respect of the potential and significance of these GEC courses for non-majors on some faculty colleagues and on many of our GTAs. Student surveys indicate that a number of our students who entered this sequence ‘not liking science’ have been pleasantly surprised at the relevancy and approach of our classes. Other students, who have been successful at high school science courses that used “skill and drill” pedagogies often express disappointment at our approach.

**Challenges:** We developed these classes coincident with expansion of staff and GTA training and have found that due to GTA turnover (33%/term) we need to engage in constant training for them on the differences between the teaching methods they have experienced and the ones we are employing.
Budget changes have resulted in an 85% decrease in participation by regular faculty in these courses; no method for dealing with this challenge has yet emerged.

**Poster #167**  
**Category: A1**  
**Primary Project or Approach:** Encouraging and Enabling Student Active Learning (Examples include Case Studies, POGIL, Clickers, Problem Based Learning)  
**Institution:** San Diego State University  
**Presenter:** Kathleen Fisher  
**Email:** kfisher@sciences.sdsu.edu  
**Co-Presenter:** Kathy Williams and Jennifer Lineback, San Diego State University  
**Field of Interest within Biology:** Biology Learning/Teaching

**Goals & Intended Outcome:** We are developing diagnostic tests in four areas: a revised version of Odom and Barrow's osmosis and diffusion test, a modified version of Anderson, Fisher & Norman's Conceptual Inventory of Natural Selection, respiration & photosynthesis (in collaboration with David Treagust), and cell division (with Mike Smith).

**Methods & Strategies:** Tests have been deployed for four years with upper division biology majors at a large public university. The multiple-choice diagnostic tests use students' commonsense ideas as distractors to assess the ability of students to select a scientifically correct idea over familiar (but incorrect) popular ideas.

**Evaluation Methods & Results:** Testing large numbers of students each semester for four years has provided invaluable opportunities for refining and validating the four tests. We are testing concepts that are taught in high school and lower division courses, yet the tests are being administered to upper division students to assess their level of understanding of these basic ideas. We would hope that all biology students would achieve an in-depth understanding of these ideas by the time they are ready to graduate, but this is not the case. We seem to be seeing gains across the four semesters, but not always consistently.

**Dissemination Activities & Plans to Disseminate:** We are nearly ready to submit a paper about and to publish the osmosis and diffusion test. We hope to do the same with natural selection and perhaps respiration/photosynthesis by the end of the summer. Cell division has been particularly challenging and definitely needs more work.

**Impacts of Project or Anticipated Impact:** The greatest impact will follow publication and dissemination. We hope that many biology faculty will develop an interest in using diagnostic tests to assess their teaching effectiveness. We'll also encourage the use of individual diagnostic test items as "tools" (problems to be presented to students) for interactive teaching in large lecture classes. We are organizing presentations by many diagnostic test developers at the American Society for Microbiology 17th Conference for Undergraduate Educators in San Diego in June 2010.

**Challenges:** It is most challenging to develop good diagnostic test items and tests. And that challenge is minor compared to the challenge of engaging biology faculty in learning to teach for comprehension rather than memorization.
**Poster #198**  
**Category:** A2  
**Primary Project or Approach:** Enhancing student learning through use of biological technologies (Microscopy and other visualization techniques, mass spectrometry, microarrays)  
**Institution:** Great Bay Community College  
**Presenter:** Sonia Wallman  
**Email:** swallman@ccsnh.edu  
**Field of Interest within Biology:** Biotechnology  

**Goals & Intended Outcome:** The goals and outcomes of the project include: Teaching students about biomanufacturing and the bioeconomy. Use biomanufacturing to teach basic biotechnology competencies in an engaging manner. Demonstrate interesting career paths in biotechnology, biomanufacturing and the bioeconomy.

**Methods & Strategies:** Use of transformation, growth and protein expression in *Pichia pastoris* to motivate students towards careers and further education in biotechnology, biomanufacturing and the bioeconomy.

**Evaluation Methods & Results:** Teacher workshop evaluation followed by student evaluation of the value of the information and hands-on activities.

**Dissemination Activities & Plans to Disseminate:** Introduction to Biomanufacturing Workshops for high school teachers to introduce teachers to *Pichia pastoris* for human biopharmaceutical protein production.

**Impacts of Project or Anticipated Impact:** Knowledge of interesting career paths previously unknown.

**Challenges:** None.

**Abstract:** Using Biomanufacturing to Teach Basic Science Concepts and Awareness of the Bioeconomy

The yeast, *Pichia pastoris* is fast becoming one of the most important organisms for biopharmaceutical production. Through the work of Tillman Gerngross at the Thayer School of Engineering at Dartmouth College in Hanover, New Hampshire and at two companies founded by Gerngross, GlycoFi and Adimab in Lebanon, New Hampshire, the glycosylation pathway of *P. pastoris* was stripped out and the human glycosylation pathway genetically engineered into the organism. In addition, *Pichia pastoris* can be transformed by an expression vector that is induced by methanol to produce its protein of interest through the Central Dogma of Biology. Now, several companies including GlycoFi (bought by Merck) and Merck in New Jersey and Pennsylvania are making human glycosylated therapeutic antibodies in *Pichia pastoris*.

During protein production induced by methanol in *Pichia pastoris*, large numbers of peroxisomes form in the cell to convert methanol to formaldehyde, then to hydrogen peroxide and finally to NADH. NADH then enters the mitochondria to produce large amounts of ATP. Because of the vast amounts of ATP generated in this process, *Pichia pastoris* can make more fully humanized proteins than any other biopharmaceutical manufacturing workhorse. Because of the unique features of the *Pichia pastoris* system, it can be used to demonstrate the nature of two cellular organelles as well as the use of this organism in the biomanufacture of recombinant therapeutic proteins.
Poster #169  
Category: A2  
**Primary Project or Approach:** Enhancing student learning through use of biological technologies (Microscopy and other visualization techniques, mass spectrometry, microarrays)  
**Institution:** Western Carolina University  
**Presenter:** Wesley Bonds  
**Email:** wbonds@wcu.edu  
**Co-Presenter:** Scott Johnson, Wake Technical Community College  
Mary Jane Paolella, Sacred Heart Academy  
William E. Schy, North Carolina Biotechnology Center  
**Field of Interest within Biology:** Biotechnology  

**Goals & Intended Outcome:** The goal of this project is to design inexpensive microarray lessons and test them in undergraduate biology laboratory settings. The array lessons, which incorporate genes in the yeast glycolysis/gluconeogenesis pathways, permit the student to critically analyze eukaryotic carbohydrate metabolism in detail.  

**Methods & Strategies:** The outstanding difference this approach offers to the teaching of metabolism is the array lab’s ability to provide active, hands-on, inquiry-based learning. Traditional instruction in carbohydrate metabolism is generally reduced to memorization of easily forgotten biochemical nomenclature and details.  

**Evaluation Methods & Results:** Evaluation of the microarray lessons lag simply because it has taken much longer than originally anticipated to move technically workable lessons into the field. We have had both formative and summative evaluation tools constructed for some time but are only now moving into a position to use them. What has been missing are appropriately trained instructors. Fortunately, about forty of these have now been trained in two different summer workshops. Briefly, our summative evaluation instrument tests the gain in student learning while our formative evaluation tracks overall progress of our lesson trials.  

**Dissemination Activities & Plans to Disseminate:** Our challenge has been to develop both the means for dissemination of lesson details as well as guaranteeing a continuous supply of inexpensive arrays. A functional lesson website now carries extensive details and teaching resources. In March, 2009, an array manufacturing enterprise was incorporated.  

**Impacts of Project or Anticipated Impact:** Impacts from the lesson are only now being realized. Microarray technology is vaguely known to most biology instructors but few have even seen an array much less performed an array experiment. It now appears that community college biotechnology programs and, surprisingly, advanced placement secondary school biology programs are interest leaders. In North Carolina, private industry rose to support teacher training in the lesson with a $20,000 grant, this even after the economic downturn. Interestingly, this pattern seems similar to the earlier adoption of polymerase chain technology in biology education a decade ago.  

**Challenges:** This project encountered a number of challenges not anticipated at its inception. Manufacturing and handling large numbers of cheap arrays was solved by sheet printing on nylon membranes then recovering them with paper punches. Reagent quality control became an issue, as did microarray shelf life. Both of these technical issues seem to be solved. Having reduced lesson lab time from sixteen to three hours, instructors responded by wanting yet shorter labs. By splitting the lesson into two halves, then performing the hybridization step out of class, the lab has been reduced to two sequential 75-minute periods.
**Poster #178**  
**Category:** A3  
**Primary Project or Approach:** Biology as related to world problems (climate issues, economics, health, service learning, community outreach)  
**Institution:** Drew University  
**Presenter:** Pamela Gunter-Smith  
**Email:** pgunter@drew.edu  
**Co-Presenter:** Roger Knowles, Drew University; Juliette Lantz, Drew University  
**Field of Interest within Biology:** Neuroscience  

**Goals & Intended Outcome:** Drew University has begun working to develop a model of science education organized around the “great challenges” facing science over the next quarter-century and emphasizing research at an earlier stage.

**Methods & Strategies:** The “Great Challenges” curriculum has 4 major components: 1) a summer research bridge program; 2) a series of freshman and sophomore seminars centered around Drew’s unique RISE program; 3) a team based research course drawing upon students from different disciplines; and 4) non-science major courses about the “Great Challenges” in science.

**Evaluation Methods & Results:** We will be assessing the program using the following outputs: number of students engaged in research, number of students who persist in research for more than one semester, the number of students engaged in group research programs. The following learning outcomes will be measured: students learning and applying scientific method, experimental techniques and laboratory skills early in their undergraduate experience. This spring, the initial Great Challenges course was offered and 19 students enrolled and 7 of those students are continuing their research during our summer research program. They are being joined by 6 students from the bridge program as well as 6 students from local high schools looking to gain valuable research experience.

**Dissemination Activities & Plans to Disseminate:** We plan to host a symposium in 2012 in which we present the results from this curricular reform.

**Impacts of Project or Anticipated Impact:** Our anticipated impacts are to increase retention in science students during the 4 years in undergraduate school, increase the number of students getting a major or a minor in science discipline, and increase the number of students who apply to graduate schools in the sciences.

**Challenges:** The major unexpected challenge is dealing with the budgetary constraints during a recession while doing curricular reform. However, the use of group and team based research appears to be servicing larger number of students in a cost effective manner.

**Abstract:** With the aid of a HHMI program grant, Drew University has begun working to develop a model of science education organized around the “great challenges” facing science over the next quarter-century and emphasizing research at an earlier stage. The “Great Challenges” curriculum has 4 major components starting with a summer bridge program targeted to students the summer before their first year at Drew. These students will join more senior Drew students and faculty engaged in on-campus summer research as part of Drew’s summer research program. The second component is a series of freshman and sophomore seminars centered around Drew’s unique RISE program (Research Institute for Scientists Emeriti), scientists who have spent decades working at companies like Merck, Schering Plough, and Novartis.

These courses will focus on the challenges in science that have inspired RISE fellows to spend long and fruitful careers in science. The third component is a team-based research course in which high-
achieving students from different disciplines will enroll in a course led by a faculty team from different departments as well as RISE fellows. The course will focus on using the knowledge, techniques, and technology from different science disciplines to explore a specific “great challenge” research question. Students from that course will be eligible to continue their team research projects during Drew’s summer research program.

The fourth component of this curriculum is to teach non-science majors about the “Great Challenges” in science as part of their breadth general education requirements. Students who participated in the team based research course will be recruited the following year to be peer leaders in these non-science majors courses which will have practical lab experiences centered around the peer leaders’ research experience. The objectives of the curriculum are to develop the science competency of all Drew students, forge better connections between all science faculty, and the Drew community, and grow the future of the sciences by attracting students not initially inclined to study the sciences.

**Poster #177**  
**Category: A4**  
**Primary Project or Approach:** Student Research introduced as an Integral Part of Traditional Courses and Introduction of Technologies New to Biology  
**Institution:** Clemson University  
**Presenter:** Barbara Speziale  
**Email:** bjspz@clemson.edu  
**Field of Interest within Biology:** Ecology and Environmental Biology

**Goals & Intended Outcome:** Our goal is to engage students in research early and often. A combination of Clemson University initiatives and grants from the Howard Hughes Medical Institute Undergraduate Science Education Program have built a science pipeline extending from K-12 schools through college with research as the unifying feature.

**Methods & Strategies:** In addition to individual research, undergraduate students may begin research projects as freshman, as members of Creative Inquiry research teams. During summers, undergraduates, Honors College incoming freshmen and talented rising high school seniors participate in faculty-mentored research projects.

**Evaluation Methods & Results:** Effectiveness of the research experience is assessed by: 1) student self-reports; 2) reports from faculty mentors; 3) professional meetings presentations; 4) publications; and 5) annual surveys of all student research alumni. Students reported that their research experiences: improved their understanding of information in science classes; encouraged them to apply and use information they had learned in other classes; improved their general understanding of the process of science; helped them to better understand scientific reports on TV, radio or in the newspaper or magazines; and provided opportunities to read original research literature.

**Dissemination Activities & Plans to Disseminate:** Descriptions of Clemson University’s student research programs have been presented at national conferences. Student researchers present the results of their projects in on-campus forums and professional society conferences.

**Impacts of Project or Anticipated Impact:** These opportunities create an environment on campus that encourages students to engage in progressively more complex and rigorous research experiences designed to improve their reasoning, critical thinking, problem-solving and communication skills.

**Challenges:** As we work towards engaging all undergraduate students in research, the challenge in science disciplines will be to provide space, funding and faculty mentors. Creative Inquiry projects in
which students work in collaborative teams expand the definition of research, allow more students to participate, and encourage students to pursue individual, advanced research projects. External funding for student projects and the support of the faculty will be essential.

**Poster #180**  
**Category:** A4  
**Primary Project or Approach:** Student Research introduced as an Integral Part of Traditional Courses and Introduction of Technologies New to Biology  
**Institution:** College of William and Mary  
**Presenter:** Margaret Saha  
**Email:** mssaha@wm.edu  
**Co-Presenter:** Mark Forsyth, Oliver Kerscher, and Matt Wawersik, College of William and Mary  
**Field of Interest within Biology:** Introductory, Integrative, and Quantitative Biology

**Goals & Intended Outcome:** One of the major goals of biological science education at the College of William and Mary is to engage undergraduate students and transform undergraduate science education through a multi-tiered approach that targets students in a variety of different ways and at different levels.

**Methods & Strategies:** Rather than focusing on a single specific approach we have developed a number of different strategies with the goal of having these diverse approaches interact synergistically. A major focus is integrating authentic research experiences and quantitative approaches at all levels of the curriculum.

**Evaluation Methods & Results:** Evaluation is coordinated by our Office of Assessment and Planning and includes: use of focus groups and written evaluations to determine attitudes toward science and research; analysis and comparison of standard William and Mary course evaluations; use of SURE and CURE surveys; comparisons with students from previous years including grades, course selection, retention, participation in research opportunities.

**Dissemination Activities & Plans to Disseminate:** The primary means of dissemination is via William and Mary websites as well as dissemination through publications and at professional meetings attended by faculty members at their respective professional meetings.

**Impacts of Project or Anticipated Impact:** Impacts include: significantly more enthusiastic ratings for courses and labs that included research experiences; increased willingness to take more advanced interdisciplinary and quantitative courses; increased retention of "at risk" students; and a significant increase percentage of students who attempted to pursue independent research in faculty laboratories.

**Challenges:** Unexpected challenges include: identifying available resources and toolkits so as not to "reinvent the wheel"; integrating the different approaches across the curriculum; including and ensuring the success and retention of a diverse group of students. These challenges were addressed by formation of faculty discussion groups and workshops and curriculum-focused retreats as well as involvement of students in some aspect of faculty-mentored research experiences.
Poster #188  
Category: A4  
Primary Project or Approach: Student Research introduced as an Integral Part of Traditional Courses and Introduction of Technologies New to Biology  
Institution: Lewis & Clark College  
Presenter: Gary Reiness  
Email: reiness@lclark.edu  
Field of Interest within Biology: Neuroscience

Goals & Intended Outcome: Lewis & Clark College’s Biology Department wants its graduates to be knowledgeable about the process of scientific inquiry, to recognize that facts are hypotheses that have been well supported by experimental evidence, to be independent learners, and to understand what issues are amenable to scientific study.

Methods & Strategies: Introductory courses focus on student-designed laboratory/field projects (research-like experiences), with extensive mentoring from course staff, and also introduce students to primary literature. Upper division courses extend this foundation to develop greater sophistication and independence of student work.

Evaluation Methods & Results: We use a variety of approaches to assess student outcomes: pre- and post-tests in introductory courses; HEDS survey results, assessment exams, and exit surveys for seniors; evaluation of senior student writing anonymously for quality of analysis and expression; and data on students’ post-graduation activities (attending graduate or medical school, working in biology-related fields, or teaching, working in law, business, etc). These data generally support the efficacy of our approaches and suggest areas where we need to devote more effort (e.g., developing quantitative skills and computational biology).

Dissemination Activities & Plans to Disseminate: We do not have a dissemination plan, nor have we discussed establishing one. Such dissemination as takes place occurs ad hoc in informal conversations at meetings with colleagues from other institutions.

Impacts of Project or Anticipated Impact: The number of students participating in research outside of courses has quadrupled in the last 15 years, and many are coauthors on publications (37 since 2004) or presentations at disciplinary conferences (20 since 2004); many others have participated in research at LC or elsewhere. When introductory courses were redesigned in 1994 to incorporate independent projects, faculty altered upper division courses to include student-designed projects. Many graduates gain employment in research labs and/or earn admission to top graduate and medical schools; some make informed decisions to pursue careers in other fields.

Challenges: The main challenge has been making clear our expectations for project design, appropriate presentation of results, and working effectively in teams, especially in introductory courses. We have therefore sought ways to make our expectations explicit and to provide students with formative feedback. For example, we discuss experimental design in "lecture"; students write “proposals” for their projects that are critiqued by classmates and course staff before projects are begun; reports are written sequentially in sections (Introduction, Methods, etc.), which are returned with comments before final drafts are due.
**Poster #182**  
**Category:** A4  
**Primary Project or Approach:** Student Research introduced as an Integral Part of Traditional Courses and Introduction of Technologies New to Biology  
**Institution:** Minnesota State University  
**Presenter:** Linda Fuselier  
**Email:** fuselier@mnstate.edu  
**Co-Presenter:** Brian Wisenden, Minnesota State University  
**Field of Interest within Biology:** Evolutionary Biology

**Goals & Intended Outcome:** The main goal of our project is to increase scientific literacy in our graduates by providing more of our students with meaningful research experiences and maximizing integration of faculty research with science education. We intend to increase the proportion of bioscience graduates that conduct and present original research related to our research programs in Chemical Behavioral Ecology of Fishes and Molecular Ecology of Bryophytes.

**Methods & Strategies:** (1) Design, assess and integrate student-directed open-inquiry experiences based on faculty research in chemical behavioral ecology and bryophyte molecular biology into a sequence of core Bioscience courses, and (2) develop two new courses, Research Design and Advanced Research, required of all students in the Ecology and Evolutionary Biology emphasis in Biosciences.

**Evaluation Methods & Results:** Numbers of students completing original research and presenting research at professional meetings at the campus or national levels has increased with the requirement of the two new research courses. Additionally, we conducted a controlled study of the impact of student-directed open-inquiry versus guided-inquiry exercises in freshman labs. Preliminary data suggest that students in a first-year introductory biology course design more creative experiments when a research question is provided compared to when students develop their own question. However, students in an upper-level molecular biology laboratory course preferred formation and testing of their own research questions. We will complete a second year of data collection and analysis this fall and will modify course and curriculum components in response to these assessments.

**Dissemination Activities & Plans to Disseminate:** Completed dissemination includes three peer-reviewed publications from student research and science education activities, presentations at two international meetings with a “best poster” award at one, and six presentations by 12 students at our Student Academic Conference. Continued dissemination plans include publication of a series of laboratory activities, and results of inquiry and science information literacy studies.

**Impacts of Project or Anticipated Impact:** We improved our Bioscience curriculum and integrated faculty research into the curriculum despite heavy teaching loads. Students now encounter science information literacy and the research process in their first year. Skills and concepts are sequenced within the curriculum to enhance science education and build up to a significant senior research experience. All students that take the core course sequence in the Ecology & Evolutionary Biology (EEB) emphasis graduate with research experience that involves the entire process of science. Faculty developed new research collaborations, and science faculty and library staff developed lessons for teaching science information literacy. The number of students in the EEB emphasis is increasing and more students express interest in conducting independent research with faculty members.

**Challenges:** In our controlled experiment comparing student-directed and guided open-inquiry, maintaining nine different sections of laboratories with six different instructors was complex and unwieldy. Inevitably data was lost or had to be omitted making necessary a second semester of data gathering. It was difficult to articulate the Research Design and Advanced Research classes across semesters with multiple faculty that all have full teaching loads. We reduced some courses to every
other semester to compensate for the new courses. Faculty buy-in on a common syllabus for Research Design required much discussion and practice. Most challenging was ensuring that students complete course prerequisites and follow the curriculum in the intended sequence before enrolling in the capstone research courses. We are improving upon this by more strict advising in the department.

Poster #186
Category: A4
Primary Project or Approach: Student Research introduced as an Integral Part of Traditional Courses and Introduction of Technologies New to Biology
Institution: The University of Montana Western
Presenter: Michelle Anderson
Email: m_anderson@umwestern.edu
Co-Presenter: Michael A. Gilbert, Michael W. Morrow, Department of Biology, The University of Montana Western; Robert C. Thomas and Sheila Roberts, Department of Environmental Sciences, The University of Montana Western
Field of Interest within Biology: General Biology

Goals & Intended Outcome: Beginning in 2005, the University of Montana Western (UMW) adopted a unique block schedule called "Experience One" that requires undergraduate students to become immersed in laboratory and field research as part of traditional courses. The goal in providing on-going, structured research experiences is to create a challenging, effective and interdisciplinary learning environment that increases student satisfaction, engagement and critical thinking performance.

Methods & Strategies: All courses at UMW have been restructured to fit a block schedule where students take one class at a time over 18 instructional days. In traditional biology and environmental science courses such as genetics, molecular biology, ecology, wildlife biology, and environmental field studies the amount of lecture is reduced in order to focus on field and/or laboratory research projects. Projects are most often constructed to address "real-world" problems through collaboration with researchers at other institutions, different government agencies or non-profit organizations.

Evaluation Methods & Results: In order to evaluate the campus-wide success of "Experience One", all students were asked to take the Cornell Critical Thinking Test and the Noel-Levitz Student Satisfaction Inventory in 2006, and the National Survey of Student Engagement in 2007-2008. Evaluations of individual classes have included a comparison of final grades before and after adopting "Experience One", along with anecdotal information on class attendance. A variety of evaluation tools such as pre- and post-course knowledge surveys and performance on professional and graduate school entrance exams are being considered for future use.

Dissemination Activities & Plans to Disseminate: Dissemination activities are largely designed as a way to inform prospective students, parents of existing students, university administrators, and Montana citizens about the success of the "Experience One" program. Articles have appeared in local Montana newspapers and the national education periodical "AFT On Campus". Students frequently present the results of their research projects to sponsoring agencies and at local and national undergraduate research symposia.

Impacts of Project or Anticipated Impact: Results of the Cornell Critical Thinking Test from 2006 show a general trend in increased performance over a test given in 2002. The Noel-Levitz Student Satisfaction Inventory in 2006 indicated an increase in student satisfaction with "student-centeredness" and "instructional effectiveness" over an inventory conducted in 1998. The National Survey of Student Engagement (NSSE) from 2007-2008 indicated that UMW scored higher on benchmarks of student engagement than similar institutions. The NSSE results also showed UMW students rank higher in cate-
Categories of "level of academic challenge", "student-faculty interaction", and "active and collaborative learning". In individual science classes, student attendance has risen as much as 40%. In the future, anticipated impacts include measurable student content knowledge and process skills improvement in individual courses and higher than average scores by UMW students taking entrance exams required by professional and graduate schools.

**Challenges:** A number of unexpected challenges arose in switching over to "Experience One". Initially a hybrid block schedule was attempted in which only science courses were taught on the block, causing massive class scheduling conflicts until the block system was adopted campus-wide. Faculty typically find teaching on the block is far more intense than the traditional semester system, which can result in faculty burnout. In order to counteract this effect, faculty are encouraged to teach only 3 of the 4 blocks offered each semester and instead use the fourth block for "professional development" activities such as research, attending conferences, manuscript preparation and curriculum development. Students, while expected to take only one class at a time, sometimes attempt to double-up on courses or work full-time. This results in scheduling conflicts when taking multiple-day field trips or conducting lengthy laboratory experiments and poor student performance in courses. We are attempting to address this problem as part of the academic advising process. Finally, the increased emphasis on research resulted in the need for more field and laboratory equipment and transportation options to accommodate all students, which presents an ongoing fundraising challenge for a small undergraduate institution.

**Poster #174**  
**Category:** A4  
**Primary Project or Approach:** Student Research introduced as an Integral Part of Traditional Courses and Introduction of Technologies New to Biology  
**Institution:** Transylvania University  
**Presenter:** Kathleen Jagger  
**Email:** kjagger@transy.edu  
**Co-Presenter:** Sarah Bray, Belinda Sly, and James Wagner, Transylvania University  
**Field of Interest within Biology:** Microbiology, Virology  

**Goals & Intended Outcome:** Our goal was to define subsets of essential research skills and incrementally imbed them throughout our biology major. Skills ranged from formulating solid hypotheses and conducting research projects to presenting research results in different scientific formats to reading and critiquing primary literature.

**Methods & Strategies:** Our strategy was to build designated skills into the core courses of our major so all majors will be required to develop them. The introductory core includes a first course on evolution and diversity and two sophomore courses: Genetics and Cell/Molecular Biology. The senior capstone is a writing intensive seminar.

**Evaluation Methods & Results:** Most of the evaluations to date have been formative in the context of each class. These included written lab reports and oral presentations, proposals submitted for student-designed research projects and scientific papers or poster presentations on final lab research projects, graded group problems in genetics, and extensive consultations on critical reviews written during the senior seminar. We have yet to design a biology program-wide summative assessment of these curriculum changes.
**Dissemination Activities & Plans to Disseminate:** A preliminary publication on the cell/molecular biology lab projects was published in December 2008. All critical reviews written by students in senior seminar are bound together as a book and are maintained in the university library.

**Impacts of Project or Anticipated Impact:** Students recognize the complexities of data collection and representation in graphical and tabular forms. Students improve their ability to use sterile techniques and cell cultures. Students have demonstrated ability to work with molecular genetics databases and learned to solve problems in groups. Seniors have read at least 25 primary sources in a term and written a critical review of that body of literature. Students that have continued on to graduate school report that they are more comfortable reading and evaluating scientific literature and giving critical presentations than their graduate school peers.

**Challenges:** Weak quantitative skills led to more intentional data and statistical analyses in the first core course. Students’ poor scientific writing skills led us to designate the cell/molecular biology course as a writing intensive class requiring written assignments with peer review and revision. Inadequate student organizational skills were addressed by allocating lab time for group planning of research projects in cell/molecular biology, staging the senior critical review assignment (chapter prospectus, annotated bibliography, chapter outlines, rough draft) and discussing each stage of the writing/revision process.

**Poster #190**  
**Category:** A4  
**Primary Project or Approach:** Student Research introduced as an Integral Part of Traditional Courses and Introduction of Technologies New to Biology  
**Institution:** University of Houston  
**Presenter:** Rupa Iyer  
**Email:** riyer@uh.edu  
**Field of Interest within Biology:** Biotechnology  

**Goals & Intended Outcome:** Students apply concepts of biology, chemistry, mathematics and engineering procedures to a spectrum of fields making use of biotechnology. In following the life cycle of a typical biotech product, students also consider the interplay between scientific discovery and society, including the importance of scientific methods and applications.

**Methods & Strategies:** Each student conducts a research project as part of the Biotechnology Research Methods and Applications course. Students collect, compare and analyze different soil samples for the presence of the organophosphorous enzyme, the pesticide degrading activity of this bacterial enzyme is often detected in soils that contain pesticides. Students then give an oral presentation on their research project.

**Evaluation Methods & Results:** New curricular materials were peer reviewed nationwide and suggestions and recommendations incorporated. In addition, the new modules were pilot tested at Brigham Young Hawaii and University of Houston. Data on four semesters of evaluation using the assessment tool, “Student Assessment of Learning Gains (SALG) indicates that overall students found the hands-on approach a great help and according to one evaluation “cleared up a lot of questions that I had from previous classes due to hands on approach”. Some students indicated that it was the first time they experienced research in class and that they were able think and observe more like a scientist.
**Dissemination Activities & Plans to Disseminate:** Modules are available on website www.bio.tech.uh.edu, P. I, Rupa Iyer conducted two sessions “Learn Something New” at the American Society for Microbiology Meeting in Fort Collins Colorado, May 2009. Several presentations, including one at St. Xavier’s College, Mumbai, India, June 2009 to discuss the new curriculum and its adoption. We have one publication in a peer reviewed journal.

**Impacts of Project or Anticipated Impact:** Overall students appear to be more motivated because the project demonstrates the potential value of scientific discoveries in everyday life. The integration of activities in high school teacher workshops and high school student camps has allowed us to seamlessly combine high school and college level instruction. We anticipate adoption by several high schools and Universities, locally, nationally and globally. We are also collaborating with other colleges in the University, including Engineering and Natural Sciences in bringing engineering and biology students to collaborate on research projects. Within a year of its inception, we have undergraduate students who are continuing their research in the Center for Life Sciences Technology.

**Challenges:** The time frame of the lab protocols had to be modified fit the duration of the lab, some of the incubation time, gel run times were performed outside of the lab to give the students more time to conduct hands-on activities. Some students found the interdisciplinary approach challenging, these students were given extra time and help from the instructor. Starting and implementing a new interdisciplinary research program needed expertise from a variety of disciplines, the challenge was to offer the interdisciplinary experience without compromising the depth of knowledge needed to understand these concepts.

**Abstract:** With an emphasis on environmental biotechnology, the new interdisciplinary research-based biotechnology curriculum developed by the University of Houston’s College of Technology in collaboration with Reactive Surfaces and Texas A & M University uses a bacterial model to study decontamination of chemicals in the environment by a plasmid encoded bacterial gene product. Laboratory exercises cover sample collection, molecular techniques of isolation, transformation, cloning gene, bioprocessing the bioproduct and applications in nanotechnology and biosensors. The soil bacterium *Pseudomonas dimutins* is a model for this project-based curriculum. A plasmid encoded gene in this bacterium is responsible for degradation of pesticides, namely organophosphorous compounds (OP) and is activated only by the presence of these pesticides in the soil, thus providing a unique method of detection of pesticides. The OP system was chosen for this project because of the ease with which it can be integrated into the undergraduate curriculum.

The bacteria are commonly found in soil and are fairly easy to isolate and grow. The OP degrading gene has been identified, cloned and expressed and the upstream and downstream processes of the protein production very well characterized. In addition, the potential application of this research in environmental biotechnology and nanobiotechnology makes it extremely valuable to undergraduate curricula as students can relate the potential values of scientific discoveries in everyday life. This approach provides a cohesive framework of interdisciplinary elements that incorporates 21st century cutting edge research and its applications into undergraduate teaching to prepare our undergraduates for future challenges in life science research. The lab curriculum is part of the new undergraduate degree offered by the college of Technology and brings together students from a variety of disciplines including technology, engineering and natural sciences.

We have successfully developed and implemented a modular and flexible biotechnology lab curriculum that takes the students right from the process of scientific discovery and its applications and spans across a variety of disciplines including biology, computers, engineering and technology. At the University of Houston, the modules have been integrated in two courses, Biotechnology Research Methods and Applications and Principles of Bioprocessing. Elsewhere, the new curriculum has been
Student Research introduced as an Integral Part of Traditional Courses and Introduction of Technologies New to Biology

Institution: University of New Orleans
Presenter: Mary Clancy
Email: mclancy@uno.edu
Co-Presenter: Karen Kandl, Western Carolina University
Nicola Anthony and Steven Johnson, University of New Orleans

Field of Interest within Biology: Genetics

Goals & Intended Outcome: A Research Tools course was developed to introduce basic research skills to Sophomore-level students, as a supporting component of the NSF-sponsored (UMEB) mentoring program for minority students. The intended outcome was for students to develop essential skills in an interactive, supportive environment.

Methods & Strategies: Group discussion of scientific papers and student presentations were central components. These activities were complemented by lab exercises illustrating a range of approaches, and included both wet-lab and field experiences. Students were given weekly feedback on their progress in attaining learning objectives.

Evaluation Methods & Results: Student progress was assessed through lab write-ups, writing assignments, in-class exams and research poster presentations. A final summary discussion assessed student satisfaction with the course; attitudes toward research; interest in continuing research; and increased confidence. The contribution of the course to the broader aims of the UMEB program, to encourage student persistence and to foster interest in scientific careers, was also evaluated. Students expressed high levels of satisfaction with their experiences in the program, and a new awareness of research as a career option.

Dissemination Activities & Plans to Disseminate: Student work has been presented in the form of posters, meeting presentations and co-authorship of research publications.

Impacts of Project or Anticipated Impact: It is anticipated that most or all of the students will be retained in science through their undergraduate studies and pursue careers in science or medicine following graduation. Students are being tracked as their careers progress. Moreover, success of the course has led the department to recognize the benefit of early, structured engagement in research thinking, and plans to expand these opportunities are under way. The anticipated impact will be improved student persistence in science and a pervasive awareness among the students of research as an attainable and attractive career.

Challenges: Many students are not accustomed to thinking about biology beyond the lecture class or lab room and have preconceived ideas that biological research is boring or difficult. The University of
New Orleans has a large proportion of minority students, but attracting these students to the UMEB program and biological research was more difficult than anticipated because of these unfounded attitudes toward biological research.

**Poster #196**  
**Category:** A4  
**Primary Project or Approach:** Student Research introduced as an Integral Part of Traditional Courses and Introduction of Technologies New to Biology  
**Institution:** University of Pittsburgh  
**Presenter:** Sam Donovan  
**Email:** sdonovan@pitt.edu  
**Co-Presenter:** Ethel Stanley, Beloit College  
**Amee Godwin, Institute for the Study of Knowledge Management in Education**  
**Field of Interest within Biology:** General Biology  

**Goals & Intended Outcome:** The goals of the LIFE LAB Project include promoting a national dialogue on innovative ways to support research-like learning experiences for all biology undergraduates; reforming laboratory education to better reflect modern biological problem solving; and, exploring the effective use of emerging opportunities for student research using e-science, information & communication technologies, and open educational resources.

**Methods & Strategies:** This project brings together diverse stakeholders from scientific, education, technology, and informatics communities to define and exemplify important pedagogical features of research-like problem solving.

**Evaluation Methods & Results:** The LIFE LAB project outcomes will include a range of resources designed to inform course design and teaching practice such as descriptions of multiple models for creating investigative laboratories, strategies for supporting scientific collaborations across sections, courses, and institutions, and design principles to guide faculty efforts as they develop novel opportunities for student research.

**Dissemination Activities & Plans to Disseminate:** A combination of face-to-face working groups, whitepapers, and disciplinary publications will supplement online community building resources designed to support the collaborative design, implementation and assessment of investigative curricular units.

**Impacts of Project or Anticipated Impact:** The LIFE LAB Project aims to change the conversation around undergraduate biology education reform to foreground innovative efforts that take advantage of scientific data repositories, powerful analysis and visualization tools, and emerging communications technologies. The most valuable impact will be the engagement of diverse students in realistic scientific problem solving and promoting an understanding of the nature of science through rich experiences doing science.

**Challenges:** Overcoming the institutional and cultural barriers to substantive biology education reform will not be a trivial undertaking. This project will emphasize both existing programs that work and incremental ways to open up laboratory experiences in order to reach the broadest possible audience.
**Poster #170**  
*Category: A4*  
**Primary Project or Approach:** Student Research introduced as an Integral Part of Traditional Courses and Introduction of Technologies New to Biology  
**Institution:** University of Puerto Rico at Cayey  
**Presenter:** Edwin Vazquez  
**Email:** edwin.vazquez4@upr.edu  
**Field of Interest within Biology:** General Biology

**Goals & Intended Outcome:** Early research experiences serve to develop skills that are inherent to the scientific process. Introductory science courses have to be redesigned so that the laboratory component becomes an experience similar to that found in any research lab and not a collection of experimental recipes, with predetermined outcomes. A general biology course has been transformed by substituting the regular lab section with investigations.

**Methods & Strategies:** The lab professor assigns small research projects to groups of 4-5 students based on his or her own research interests. The regular three hour lab period is used for lab meetings, discuss papers and analyze data, among other things. Students work on their projects during the semester adjusting their own schedules. At the end of the semester they present their results, both orally and in a poster format, in a symposium held at the Institution.

**Evaluation Methods & Results:** A key feature of our program is that we do not select students based on the usual indicators of success. Rather, we choose a section at random and offer all students matriculated the chance to participate. Preliminary data from a longitudinal study indicate that this approach helps develop work group, communication and critical thinking skills.

**Dissemination Activities & Plans to Disseminate:** Since 2004 students have made 30 presentations of their research projects at UPR-Cayey and 32 presentations at symposia held in Puerto Rico and the United States. Faculty presentations have been made at Harvard University, the University of Florida and the American Society for Cell Biology. A paper on our program is in progress.

**Impacts of Project or Anticipated Impact:** The program has had a significant impact on student’s research experiences and their exposure to some of the latest research techniques. Sixty percent of participants have expressed an interest in pursuing a graduate degree in the sciences. The program has provided a research experience to approximately 200 students, mostly in their first and second year, who otherwise would have never been able to participate in any meaningful scientific research. A continuation project using a similar approach will begin in August under the auspices of the Howard Hughes Medical Institute and its Science Education Alliance.

**Challenges:** A challenge has been to convince other faculty members that this approach will not negatively impact student’s expected traditional laboratory skills. This has been accomplished by incorporating some traditional laboratory exercises where students are trained in the use of different lab equipment, independent of their research projects.

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**Poster #185**  
*Category: A5*  
**Primary Project or Approach:** Other: Research-based laboratory course  
**Institution:** Carnegie Mellon University  
**Presenter:** A. Javier Lopez  
**Email:** jlaa@andrew.cmu.edu  
**Co-Presenter:** Jonathan W. Jarvik and Kathryn E. Sheldon, Dept. of Biological Sciences, Carnegie Mellon University
**Field of Interest within Biology:** Genomics

**Abstract:** Implementation of HHMI Science Education Alliance Mycobacteriophage Genomics Laboratory Course at Carnegie Mellon University

We designed this research-based course with support from the Howard Hughes Medical Institute Science Education Alliance program to stimulate interest in biological research among freshmen in the Mellon College of Science at Carnegie Mellon University. We selected 10 female and 11 male students using an application essay, without regard to academic record or major. The students represented a broad range of backgrounds, interests and personalities. We provided opportunities for individual and team work, to develop self-confidence and collaborative skills. In the Fall, each student isolated one mycobacteriophage from an environmental sample and characterized its morphology and DNA restriction pattern. The group then chose one phage (“Island-3”) and prepared its DNA for genome sequencing by the Joint Genome Institute. The students also performed experiments to develop a more concrete understanding of infection, replication and viral assembly.

Experiments included scanning and transmission EM of plaque sections, in which phage adsorption and intracellular intermediates in viral assembly could be observed. The Spring was devoted to coupled bioinformatic and experimental analyses of the sequenced phage. Students carried out their own finishing experiments to fill gaps and resolve poor quality regions in the preliminary sequence from JGI. Sequence alignments revealed that Island-3 belongs to a small family previously defined by two phages with similar morphology. Students then compared the genomes and predicted genes of Island-3 and its two relatives to generate and test hypotheses about their life cycles and regulation, including ability to lysogenize, integration into the bacterial genome, and patterns of immunity.

This approach was very successful and had multiple benefits: 1) students developed collective and individual ownership of projects that generated many learning opportunities; 2) students experienced the entire research cycle, including initial observations, generation of hypotheses, design of tests and experimental validation; 3) the value of combining computational and experimental approaches was highlighted by experiments that revealed novel unexpected behavior; 4) students made novel discoveries about the biology of phages that have significance for basic research in microbiology and molecular evolution and may have practical value against diseases such as tuberculosis.

Coupling bioinformatic and experimental studies guided by preliminary sequence maintained student engagement while the genome was being completed at JGI and after they discovered the high degree of similarity between Island-3 and one of its previously known relatives. Student feedback and behaviors indicate that the course was extremely successful in motivating an interest in further biological research and enhancing the understanding of biological concepts and the research process. More thorough formal evaluation of outcomes across the 12 participating institutions is being conducted through pre-and post-course surveys coordinated by the SEA program.

**Poster #166**
**Category:** A5
**Primary Project or Approach:** Other: Promote undergraduate research
**Presenter:** Lida Beninson
**Email:** lbeninso@nsf.gov
**Field of Interest within Biology:** General Biology

**Goals & Intended Outcome:** The Undergraduate Research and Mentoring (URM) Program aims to increase the diversity of individuals pursuing graduate studies in all areas of biological research. This
report evaluates if the URM program is successful at recruiting underrepresented minorities into undergraduate research opportunities.

**Methods & Strategies:** The URM PIs are required to create innovative programs with well-defined research topics and extracurricular activities to enable student participants to become independent thinkers and communicators. Faculty mentoring and undergraduate research training prepare students for entry to and success in graduate school.

**Evaluation Methods & Results:** We collected surveys from 33 URM PIs addressing their summer and academic-year programs representing over 200 student participants. These surveys help determine if the URM program successfully recruits underrepresented minorities. Analysis of the survey responses indicates that the URM program is effective in recruiting underrepresented minorities, students with disabilities, and women to the biological sciences, particularly ecological and environmental science.

**Dissemination Activities & Plans to Disseminate:** Results from the survey analysis of the URM program were used in an internal National Science Foundation (NSF) briefing. Additionally, the data will be presented to several different panels throughout the NSF, in an effort to determine if the program successfully broadens participation in the sciences.

**Impacts of Project or Anticipated Impact:** This evaluation provides valuable insight for designing programs that aim to broaden participation in the sciences at the collegiate level. While the URM program is very successful at recruiting underrepresented minorities and women, follow-up research will determine if these participants are remaining in the biological sciences and entering graduate programs or science careers. It will also be interesting to see if these participants affect their peers by influencing more underrepresented minority students to pursue degrees in the biological sciences.

**Challenges:** The greatest challenge in this evaluation was interpreting the survey responses so that the analysis was consistent, especially for open ended questions. The PIs tended to interpret questions differently from one another, so responses needed to be carefully analyzed to ensure quantitative consistency.

**Poster #194**
**Category: A5**
**Primary Project or Approach:** Other: Combination of student research, learning through instrumentation, and world problems
**Institution:** New Mexico State University
**Presenter:** Elba Serrano
**Email:** serrano.101@gamil.com
**Co-Presenter:** Mary O'Connell, Antonio Lara, William Quintana, Cathilia Flores, Brook Milligan, and Graciela Unguez, NMSU
**Field of Interest within Biology:** Interdisciplinary: Plant chemistry/discovery; genomics/computation

**Goals & Intended Outcome:** The NMSU MBRS RISE program (NIH GM R25GM061222) aspires to broaden the number of students from groups traditionally underrepresented in the sciences who achieve a doctorate. NMSU RISE supports the research activities of a student pipeline from freshmen to doctoral students. The Medicinal Plants of the Southwest (MPSW) Summer Workshop is a RISE activity that targets entering freshmen and non-majors. We expect that participation in MPSW will motivate students to apply for individually mentored positions (e.g. RISE, AMP, HHMI) and ultimately, to pursue doctoral degrees and careers in biomedical research.
Methods & Strategies: Undergraduate teams (8 teams of 3) design and execute independent research for 6 weeks using regional plants with medicinal value. Students are provided training and access to state-of-the-art automated extraction, chromatography and detection instrumentation, and to 96-well format bioassays as well as instruction in scientific ethics and written communication skills. Teams present original results at a concluding capstone poster session. A faculty team with expertise in chemistry, plant sciences, genetics, and assessment collaboratively develops materials. Former student participants return as workshop assistants in subsequent years.

Evaluation Methods & Results: Pre and post test assessments of attitudes towards biomedical research and science have been conducted for ~9 years. A database has been developed for tracking and analysis of the over 160 student participants (2000-2009). Typically we increase the number of participants who enjoy science, who are comfortable explaining science, and who expect to continue in science as measured by the paired pre and post surveys. Depending on the cohort, as many as 65% of the participants continue to participate in research programs. The program has provided inquiry based laboratory experiences for women (~67%) and URMs (~70%).

Dissemination Activities & Plans to Disseminate: We maintain a web site with pdf versions of the activities, protocols, etc for download http://medplant.nmsu.edu and we disseminate findings at national meetings that aim to increase the representation of URM in science careers. We have published the results of the early student cohorts in a journal article: O’Connell and Lara (2005) From Curanderas to Gas Chromatography. J Coll Sci Teach 34:26-30. We are launching a long term analysis of the career paths of student cohorts and aim to publish our findings.

Impacts of Project or Anticipated Impact: Among the guest faculty who participate in the summer workshop we see an interest in changing instruction methods. Among the students who participated we see many who enter biomedical graduate degree programs and many who are pursuing research careers. We see a continued team behavior in how they approach their science classes after MPSW; they develop study groups around the peers they meet in the summer workshop. This model can be replicated in other disciplines as well. We used the MPSW model as a template for a second summer workshop (2010), intended to recruit majors who have not decided on a career path. The Genomes Team Discovery Workshop will leverage new instrumentation (a Roche Genome Sequencer acquired with NSF MRI funds) to develop an inquiry based workshop where students obtain genomics sequences with the pyrosequencer, apply bioinformatics skills in their analysis, and evaluate hypotheses about genomes, transcriptomes, and biodiversity.

Challenges: This approach is expensive in time and resources. We continue to pursue extramural funds to conduct the program. Altering instruction in the classroom so that this type of approach can be used more broadly has not been achieved yet. Providing the training, resources and release time that enable faculty to independently implement this model remains a major challenge.

Abstract: The NMSU MBRS RISE program (NIH GM R25GM061222) aspires to broaden the number of students from groups traditionally underrepresented in the sciences who achieve a doctorate. NMSU RISE supports the research activities of a student pipeline from freshmen to doctoral students. The Medicinal Plants of the Southwest (MPSW) Summer Workshop is a RISE activity that targets entering freshmen and non-majors. We expect that participation in MPSW will motivate students to apply for individually mentored positions (e.g. RISE, AMP, HHMI) and ultimately, to pursue doctoral degrees and careers in biomedical research. Undergraduate teams (8 teams of 3) design and execute independent research for 6 weeks using regional plants with medicinal value. Students are provided training and access to state-of-the-art automated extraction, chromatography and detection instrumentation, and to 96-well format bioassays as well as instruction in scientific ethics and written communication skills.

Teams present original results at a concluding capstone poster session. A faculty team with expertise in chemistry, plant sciences, genetics, and assessment collaboratively develops materials. Former stu-
dent participants return as workshop assistants in subsequent years. Pre and post test assessments of attitudes towards biomedical research and science have been conducted for ~9 years. A database has been developed for tracking and analysis of the over 160 student participants (2000-2009). Typically we increase the number of participants who enjoy science, who are comfortable explaining science, and who expect to continue in science as measured by the paired pre and post surveys. Depending on the cohort, as many as 65% of the participants continue to participate in research programs. The program has provided inquiry based laboratory experiences for women (~67%) and URMs (~70%). We maintain a web site with pdf versions of the activities, protocols, etc for download http://medplant.nmsu.edu and we disseminate national meetings that aim to increase the representation of URM in science careers. We have published the results of the early student cohorts in a journal article: O’Connell and Lara (2005) From Curanderas to Gas Chromatography. J Coll Sci Teach 34:26-30.

We are launching a long term analysis of the career paths of student cohorts and aim to publish our findings. Among the guest faculty who participate in the summer workshop we see an interest in changing instruction methods. Among the students who participated we see many who enter biomedical graduate degree programs and many who are pursuing research careers. We see a continued team behavior in how they approach their science classes after MPSW; they develop study groups around the peers they meet in the summer workshop.

This model can be replicated in other disciplines as well. We used the MPSW model as a template for a second summer workshop (2010), intended to recruit majors who have not decided on a career path. The Genomes Team Discovery Workshop will leverage new instrumentation (a Roche Genome Sequencer acquired with NSF MRI funds) to develop an inquiry based workshop where students obtain genomics sequences with the pyrosequencer, apply bioinformatics skills in their analysis, and evaluate hypotheses about genomes, transcriptomes, and biodiversity. This approach is expensive in time and resources and we continue to pursue extramural funds to conduct the program. Altering instruction in the classroom so that this type of approach can be used more broadly has not been achieved yet. Providing the training, resources and release time that enable faculty to independently implement this model remains a major challenge.

**Poster #165**
**Category:** A5
**Primary Project or Approach:** Other: Implementing Innovations and Assessing their Impact
**Institution:** Saint Louis University School of Medicine
**Presenter:** Gul A. Jendrisak
**Email:** gjendris@slu.edu
**Field of Interest within Biology:** Microbiology, Virology

**Goals & Intended Outcome:** The goal was to motivate the 40% of the class found to be academically at-risk (grade C- or below on the midterm exam) in an Undergraduate Microbiology course to change their trajectory from failure to success. The intended outcome was to encourage these students to participate fully in a set of outside the classroom tasks geared towards subject mastery.

**Methods & Strategies:** The employed strategy to empower at-risk students was based on Bundle Theory, which states that simultaneous implementation of 3 to 5 cohesive evidence-based tasks will lead to improved work performance, search for improvement and promote systemic change over a one-time intervention. The bundle tasks included: 1) personal conference, 2) weekly online quizzes, 3) review sessions, 4) online practice exam and 5) focused research project(s).

**Evaluation Methods & Results:** Bundle task participation was necessary for the 46 at-risk students and offered as an option for the 71 not-at-risk students. Retrospective analysis of Bundle compliance and
test scores for at-risk students (n=46) demonstrated significant improvement in the bundle-met students (n=24) over the bundle not-met students (n=22) for final exam scores (p<.0001), interval score improvement between final and midterm scores (p<.0003) and neared final exam scores of the not-at-risk students. Interestingly, 73% of the not-at-risk students met the bundle (sans the personal instructor conference) and also achieved significantly higher final exam scores over this student group who did not meet the bundle.

**Dissemination Activities & Plans to Disseminate:** Although targeting the at-risk students, interest in task activities spontaneously expanded throughout the whole class and has generated interest in other course instructors. This approach will be incorporated into the future Microbiology curriculum and experience shared with future Microbiology students to encourage intrinsic motivation of students to this process improvement.

**Impacts of Project or Anticipated Impact:** Beyond test score improvement associated with meeting the bundle that was statistically analyzed, the student feedback reflected a strong and positive response to this program as summarized by the following student quotes: “Met with me after my poor performance after midterm to discuss my progress and gave me tips on how to do better”, “The course gave a lot of opportunities to improve your grade.” “The practice test online before the final was helpful.” “The review sessions were so incredibly helpful” “I believe that students should be encouraged to study and really learn the stuff. This was certainly done by the teacher.” “She was available to me upon request and discusses any questions I had outside of class.”

**Challenges:** Some unexpected challenges were found. Many students lacked an adequate foundation in basic science to be fully prepared for this class. Some remedial work was needed. Student resistance to the extra work in performing these tasks had to be overcome. The instructor’s perseverance in convincing students, particularly the at-risk-students, of the importance for the task bundle was key. The students also needed to see personal success, which was met by self-improvement in online quiz scores and high performance on the online practice final exam. Students who met the bundle generally entered the final examination confident in their understanding and knowledge of the course material. Students who performed poorly on the final exam reported regret in not participating fully in the task bundle.

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**Poster #193**
**Category:** A5
**Primary Project or Approach:** Other: Teaching Students to Work and Think Like Biologists Teaching Students to Work and Think Like Biologists
**Institution:** Stony Brook University
**Presenter:** Joan Miyazaki
**Email:** joan.miyazaki@stonybrook.edu
**Co-Presenter:** Marvin O’Neal, Stony Brook University
Deborah Spikes, Stony Brook University
**Field of Interest within Biology:** Evolutionary Biology

**Goals & Intended Outcome:** To graduate informed citizens who understand the nature (strengths and weaknesses) of biological research or can contribute to the national dialogue on the role of science in society. We hope our students understand how: biology is done; how new information is obtained; and have the skills and insights to apply this knowledge.

**Methods & Strategies:** Students learn common laboratory procedures and instrumentation; they learn new skills using standardized methodologies (new tools, reading scientific literature, etc.), interviews with researchers as introduction to research practices; transitions from structured labs to independent experiments. Lab activities are done in collaborative groups, writing, oral presentation, and reading primary literature is part of their year long lab experience.
Evaluation Methods & Results: Students write lab reports, take exams, quizzes, and practical exams. They take pre- and post-tests, write reflections as part of their notebook journal, and take competency and GALT (logical thinking) tests as part of their evaluations.

Dissemination Activities & Plans to Disseminate: We have two semesters of laboratory manuals that describe the activities for students, we are in the process of developing an instructor’s guide to help new instructors learn to use the activities to maximize student involvement. We have done interviews for campus TV broadcasts to explain how active learning is achieved in the lab and in lectures. We have participated in NY State Assessments and given presentations at their conferences. We are in the process of writing papers describing a couple of our most successful practices, podcasting laboratory preparation information, and student presentations of primary research articles.

Impacts of Project or Anticipated Impact: Student Impact: Students are required to be active participants in all lab activities including preparation, planning experiments, data analysis and interpretation, critique, and communication. Our tests deemphasize memorized terms (Bloom’s Level 1), instead we strive to have tests measure higher level (Bloom’s 2-4) skills in evaluating and conducting experiments. Biology Program: The transformation of the introductory labs included a de-coupling of labs from lecture so the labs could focus on skill in doing science rather than on content. This also reduced the number of lab experience required of students at the introductory level.

Challenges: Student Resistance: Students are not accustomed to having flexible, creative input into their science lab activities. It is difficult for many students to perform experiment that are not explicitly laid out for them. We have developed a sequence of labs to develop the ability to think of science as inquiry and problem solving. Lab Prep Staff: Staff members are unaccustomed to maintaining labs in which students are supposed to take more responsibility for their lab setups. The staff has to cope with unexpected consequences of "creative" student activities. We have organized our "design" labs around a range of topics and instrumentation to narrow the kinds of new experiments students design planning and organization are key.

Abstracts: How to Work and Think like a Biologist

Biologists work with facts, ideas, instrumentation, and questions—they collaborate, communicate, keep up with current research, and solve problems—students should develop these professional skills. BIO204 & BIO205 are sequential introductory undergraduate biology laboratories that focus on development of critical thinking and problem solving skills. They transition a student from memorization and cookbook labs to guided inquiry labs and culminate with independently designed experiments as capstone experiences. These laboratories are explicitly planned to train students in scientific thought and inquiry, to make scientific observations, to read and interpret primary research articles, to design experiments, and use modern instrumentation. Activities are designed to develop skill in identifying the objectives of a project, in thinking critically and creatively, in categorizing concepts, making connections, and understanding and using new terminology. Use of computers and statistics, and modern data acquisition instrumentation are an integral part of most labs. Students collaborate as a team in a range of roles and practice providing constructive feedback to their peers. Since the face of biology is constantly changing, activities in molecular genetics, structural biology, proteomics and bioinformatics are part of the lab curriculum. Successful students know common laboratory practices and procedures, can conduct basic experiments, and understand experimental design using scientific reasoning. They design, conduct, analyze, and present their own experiments in one of these capstone experiences. Our objective is to have students prepared for upper division biology labs and ready to participate in undergraduate research.
**Poster #187**  
**Category:** B1  
**Primary Project or Approach:** Assessment (Concept Inventories, critical thinking, other)  
**Institution:** Georgetown University  
**Presenter:** Heidi Elmendorf  
**Email:** hge@georgetown.edu  
**Co-Presenter:** Maria Donoghue, Peter Armbruster, and Ronda Rolfes, Georgetown University  
**Field of Interest within Biology:** General Biology  

**Goals & Intended Outcome:** The Biology Department at Georgetown University has established 10 learning goals on science process and biological concepts for our majors and we are evaluating learning outcomes with respect to both of these learning goals. This effort is being undertaken to evaluate the efficacy of our academic program.  

**Methods & Strategies:** Our range of assessments includes both national and home-grown tools that allow us to collect student performance data and student self-reporting data. We use the Biology GRE as an indicator of student understanding of biological concepts, a scientific literature assessment tool we have developed, and a survey of the required senior thesis experience. We are making an effort to collect data from both early-stage students and seniors to better measure learning gains during their program of study.  

**Evaluation Methods & Results:** We have met with strong student support for this work and have high participation rates on all assessments. By itself, this high level of student engagement suggests a strong sense of student ownership in the department -- a key goal for us. Analysis of the GRE exams, taken in the fall by both 2nd and 4th year students, provides evidence for an imbalance in our biology curriculum that downplays ecology and evolution topics. Results from both the scientific literature assessment and the senior thesis survey suggest that our department does not provide either sufficient structured exposure to the scientific literature or sufficient training in written and oral communication.  

**Dissemination Activities & Plans to Disseminate:** To date we have only presented these data to the full department and at campus-wide meetings involving assessment teams from different departments. The assessment approach, our challenges and findings have proven very helpful to other assessment teams at Georgetown as we shape a campus-wide academic assessment effort. In the future we plan to write about this project and our findings for publication.  

**Impacts of Project or Anticipated Impact:** The data from our analysis of the GRE exam have led us to substantially revise our curriculum to include a distribution requirement that will maintain breadth in the Biology curriculum beyond the first year. The student self-reporting from the senior thesis survey and the direct evidence from the scientific literature assessment are leading us to experiment in the coming years with a new writing-in-the-discipline requirement to address these shortcomings.  

**Challenges:** The unexpected challenges have been numerous but also ultimately quite helpful in ensuring the validity of our assessment efforts. Aside from the inevitable logistical miscalculations, our challenges exist mostly with respect to the volume of data we have acquired and with the evaluation of responses to open-ended questions.  

**Poster #184**  
**Category:** B2  
**Primary Project or Approach:** Determining key concepts and competencies  
**Institution:** Davidson College  
**Presenter:** Laurie Heyer
Email: laheyer@davidson.edu
Co-Presenter: Chris Paradise and Malcolm Campbell, Davidson College
Field of Interest within Biology: Bioinformatics

Goals & Intended Outcome: We have developed an introductory biology curriculum based on how people learn best, one that encourages students to construct their own knowledge and connects new material to what students already know. The goal is to help students discover how to do science rather than just memorize facts.

Methods & Strategies: We focus on five "big ideas" of biology, each one at five levels of organization. Students discover biology through interpretation of real figures and data in a problem-based approach; connect ethical, legal and social implications with the material; and use mathematics to explain or predict experimental outcomes.

Evaluation Methods & Results: We plan to assess learning outcomes in five areas: factual knowledge, experimental design, data interpretation, quantitative analysis and scientific ethics. The instrument will be applied to introductory biology courses at different institutions, including classes that do and do not use our materials.

Dissemination Activities & Plans to Disseminate: We are working on a textbook that implements our approach to the first year biology curriculum, and plan to publish the results of our assessment in peer-reviewed journals.

Impacts of Project or Anticipated Impact: First-year courses for biology majors are overflowing with detailed information about too many examples in an attempt to cover every teacher's favorite topic. Books are bloated with factoids, encouraging students to cram for exams rather than understand the big ideas. Critical thinking and data interpretation skills are often crowded out by the march through the material. Our approach provides a way to address these problems, and we anticipate that our curriculum will better train biologists for answering the questions of the 21st century.

Challenges: Designing a new approach to the first year biology curriculum is full of challenges: identifying the big ideas, finding the best stories to illustrate the ideas at different scales of life, making original sources accessible to first year students, explaining the mathematics behind biology at a pre-calculus level, and striking just the right tone when discussing hot-button ELSI topics. Implementation of this new approach is challenging for students who are asked to unlearn bad habits formed in high school, and instructors who must change the way they teach and assess.

Poster #183
Category: C1
Primary Project or Approach: Faculty Development (from graduate students through mature faculty)
Institution: Brigham Young University
Presenter: Donald Breakwell
Email: breakwell@byu.edu
Co-Presenter: Rebecca Buxton, University of Utah
Field of Interest within Biology: Microbiology, Virology

Goals & Intended Outcome: The American Society for Microbiology Conference for Undergraduate Educators (ASMCUE) is an annual four-day interactive conference sharing the latest information in the biological sciences and education research. One of the aims of the conference is to provide a venue...
for development of community college and early-career faculty. We also want them to be included in the society and to attend again.

**Methods & Strategies:** Strategies targeting this population include advertisement on society bulk emails, and a podcast on the meeting website. Sessions include navigating a way through the tenure review process, specific events for first-timers, opportunities for them to present their best teaching activities and to receive feedback from their peers, peer-reviewing submitted curriculum projects, and an opportunity to receive travel grants.

**Evaluation Methods & Results:** ASCME 2009, the 16th year of the conference, had 252 attendees (down from 331 in 2008). Of the participants, approximately 51% were first-time attendees. There were 16 international attendees representing 11 countries. Thirty-one attendees received travel awards. Many of these awardees were from underrepresented or small enrollment schools.

**Impacts of Project or Anticipated Impact:** Participants evaluated the conference using an on-line assessment tool. Of all participants responding to the 2009 post-conference survey, approximately 80% rated the conference 8 or higher on a 10-point scale (with 10 being outstanding). Additionally, 80% rated the organization and flow of the conference above average. Of those submitting abstracts, approximately 80% found the quality of the submission process above average. For conference sessions, 92% thought the plenary lectures above average, and 72% found the conference above average for networking opportunities. Only 2% of participants rated the conference as less than satisfactory. Approximately 25% of participants had attended the conference more than 4 times.

**Challenges:** Most difficulties with this conference had to do with inherent problems of the site, but not the conference itself. We continue to reach out to community college and early-career faculty. ASM is currently in the process of moving its very popular “listserves” to a “Social Networking” format that should enhance the deep sense of community that this gathering has already created.

**Poster #164**  
**Category:** C1  
**Primary Project or Approach:** Faculty development (from graduate students through mature faculty)  
**Institution:** Michigan State University  
**Presenter:** Diane Ebert-May  
**Email:** ebertmay@msu.edu  
**Co-Presenter:** Jennifer Momsen, Michigan State University  
**Tim Henkel and Terry Derting, Murray State University**  
**Field of Interest within Biology:** General Biology

**Goals & Intended Outcome:** Faculty Institutes for Reforming Science Teaching (FIRST IV) is a professional development program for postdoctoral scholars designed to shape their beliefs about and approaches to teaching undergraduate biology toward a learner-centered classroom, thereby resulting in improved student learning.

**Methods & Strategies:** Teams of faculty leaders in the FIRST national network implement professional development workshops, provide mentoring in teaching and long-term support for postdocs. Postdocs use backward design to construct an entire introductory biology course based on scientific teaching. The postdocs will begin their new positions formally prepared to teach with a course in hand.

**Evaluation Methods & Results:** The project will evaluate the effect of professional development on postdoctoral scholars’ conceptualization and implementation of the scientific approach to teaching and
active student-centered learning. Specifically, we will evaluate the extent to which FIRST participants apply what they learned from the workshops (a) during their mentored teaching experience and (b) subsequently as junior faculty. We will also compare the effectiveness of our new approach to professional development with the model used in previous FIRST projects. We will evaluate the degree to which the RFS leaders continue to advance their abilities to implement workshops, enhance their own teaching, and engage in scholarly work about their teaching.

**Dissemination Activities & Plans to Disseminate:** Postdoctoral scholars will disseminate their courses through the FIRSTIV web site and the FIRST Assessment Database, which will link to websites of the National Postdoctoral Association, the National Digital Library, and scientific societies. We will publish (in scientific journals) as presents the model and findings based on analyses of the FIRST IV participants over time.

**Impacts of Project or Anticipated Impact:** FIRST IV will advance biology teaching reform nationally by validating the utility of professional development prior to assuming teaching responsibilities in a faculty position that includes a teaching component. The project will directly impact the faculty and students in at least 200 biology departments at institutions around the country that hire our FIRST IV postdocs. The resulting community of postdoctoral scholars will generate rigorous, tested introductory biology courses and associated assessments that are readily adaptable by biology departments nationwide.

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**Poster #195**
**Category:** C1

**Primary Project or Approach:** Faculty Development (from graduate students through mature faculty)
**Institution:** New Mexico State University
**Presenter:** Elba Serrano
**Email:** serrano@nmsu.edu
**Co-Presenter:** Boris Kiefer and Vicente Lombraña, NMSU
**Field of Interest within Biology:** Interdisciplinary/Nano(bio)science

**Goals & Intended Outcome:** The New Mexico Nanoscience Education Network (NMNEN) seeks to increase the number of women and underrepresented minority students who have the knowledge and skills necessary to participate in cutting-edge STEM research and to address the learning needs of non-traditional students, many of whom are first generation college students and minorities (Hispanic and Native American).

**Methods & Strategies:** NMNEN organizes workshops that provide training in nano(bio)science and in course development. Project participants collaborate across departments and institutions to identify nano(bio)science teaching themes. A pilot undergraduate Nanobioscience course was offered in 2008 as a collaborative effort of the co-PIs and free standing modules are under development for dissemination at the next workshop.

**Evaluation Methods & Results:** Activities are evaluated by an external advisory committee and by a professional external evaluator who also provides training for faculty in the integration of assessment into the design of learning materials. Faculty workshops, public lectures, and student activities are evaluated through distributed questionnaires and pre and post tests. We have discovered that faculty at 4 year and 2 year institutions have complementary scholarly expertise that can be integrated to develop novel learning materials. In the evaluations of the pilot nanobioscience course, students favored team activity approaches. Interestingly, team projects were ranked very low, while Q&A student ses-
ADDITIONAL POSTER ABSTRACTS

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The project has provided professional development for the community college faculty co-PI in grantsmanship. The co-PIs and network participants engage in developing a curriculum that promotes and emphasizes interdisciplinary education. The developed teaching modules will be tested in both 2-and 4-year colleges. The results of these tests will show if it is possible to develop universal teaching modules that can be used simultaneously in 2- and 4-year colleges. If not we hope to identify the barriers and determine if they can be overcome in a time efficient and effective manner. We anticipate that holding the next workshop as a satellite to the Center for Integrated Nanotechnology (CINT) meeting will aid in growing the network and increase the number of teaching modules significantly.

We have learned about the exceptional challenges faced by community college faculty in New Mexico, especially those tasked with serving high numbers of Native American students. Many of the faculty report insufficient time for the development of teaching materials. 2-year faculty report limited computer and laboratory resources. We believe that providing teaching modules remedies the time issue of updating and actualizing course content to reflect the advances in STEM disciplines more immediately and to increase the scientific and technological literacy of our graduates. A current challenge is to find efficient ways to cope with copyright issues that complicate the use of images from original literature into teaching materials that are disseminated through our portal. Supported by NSF DUE #0633736.

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Poster #189
Category: C2
Primary Project or Approach: Developing Materials to Support Undergraduate Education in Biology (textbooks (virtual and hardcopy), multimedia, access to sophisticated databases)
Institution: Association of American Medical Colleges
Presenter: Jen Page
Email: jpage@aamc.org
Co-Presenter: Karen Mitchell, Association of American Medical Colleges
Field of Interest within Biology: General Biology

Goals & Intended Outcome: The Association of American Medical Colleges is conducting a feasibility study on how to support quality science education at low resource institutions that will help to prepare a diverse student population for medical school. One possibility is to expand AAMC's MedEdPORTAL, a free peer-reviewed repository for medical and oral health teaching materials, assessment tools, and faculty development resources, to include pre-medical content.

Methods & Strategies: As part of feasibility study for PreMedEdPortal, a needs analysis will be conducted, including a survey of pre-health programs, undergraduate science faculty, and pre-health advisors that are potential users, contributors, and reviewers of teaching materials. A pilot with a small number of undergraduate pre-medical programs is also being considered.

Evaluation Methods & Results: One of the outcomes of the feasibility study is to identify measures by which the success of PreMedEdPORTAL may be evaluated. Current outcome measures of interest are number and quality of submitted teaching materials, frequency of use of teaching materials, self-reported value of using materials, instructor reported classroom evaluation data, impact at low resource institutions, impact on student academic achievement.

Dissemination Activities & Plans to Disseminate: Teaching materials in PreMedEdPORTAL would be distributed on the web, via a free searchable repository of quality peer-reviewed pre-med science teaching materials. During the feasibility study, potential users will be identified and surveyed to help develop a marketing plan to ensure user awareness of the resource, especially at low-resource institutions.

Impacts of Project or Anticipated Impact: The ideal impact of a project like PreMedEdPORTAL would be to enhance student learning in the sciences, especially for pre-med students at low-resource institutions, by providing faculty free access to high quality peer-reviewed teaching materials that exemplify best practices in science education for use in the classroom.
Challenges: By conducting a feasibility study, we hope to uncover the challenges at the start of the project and incorporate solutions to these challenges into the implementation of PreMedEdPORTAL. Some early challenges are the broad scope of science content, future changes in pre-medical curriculum, faculty habits related to use of teaching materials created by other faculty, time required to create sharable teaching materials, incentives for sharing teaching materials, and the peer review process.

Poster #181
Category: C2
Primary Project or Approach: Developing Materials to Support Undergraduate Education in Biology (textbooks (virtual and hardcopy), multimedia, access to sophisticated databases)
Institution: Ecological Society of America
Presenter: Jennifer Riem
Email: jennifer@esa.org
Co-Presenter: Teresa Mourad, Ecological Society of America
Field of Interest within Biology: Ecology and Environmental Biology

Goals & Intended Outcome: The Ecological Society of America advances undergraduate education through several related programs which seek to increase the inclusion of cutting edge science and effective pedagogy in ecology teaching. Key intended outcomes include improved faculty skills and increased activity in both developing and publishing innovative teaching materials.

Methods & Strategies: Through EcoEd Digital Library (EcoEd DL) and Teaching Issues and Experiments in Ecology (TIEE), ESA provides peer-reviewed publication venues for education materials and facilitates the development of an active community of authors and users. Through its NEON Education initiatives, ESA is engaging faculty to help build capacity for classroom use of continental-scale datasets.

Evaluation Methods & Results: Success of EcoEd DL and TIEE have been measured by the number and variety of resources published through each website, web traffic statistics, and evaluation of TIEE faculty who participated in a research practitioner project. Since 2004, TIEE has published six volumes which include a total of 11 Research Papers, 23 Issues (Figure Sets and Data Sets), and 20 Experiments. Since 2009, EcoEd DL has published 269 resources and has over 3000 registered users. The first NEON Education workshop is still in its follow-up period, and our plans to evaluate it include surveys administered after the event that measure participants’ understanding of student-active teaching using continental-scale data.

Dissemination Activities & Plans to Disseminate: For all of these projects, resulting teaching materials have been disseminated through EcoEd DL and TIEE, which are publicly accessible and actively promoted at ESA events. In addition, one article that provided an overview of current initiatives was published in the ESA Bulletin in 2008. A second article describing the results of a survey of EcoEd DL users will also be published in July 2009.

Impacts of Project or Anticipated Impact: ESA’s undergraduate education projects are anticipated to improve the ability of faculty to find high-quality teaching resources that meet their needs, increase publication of resources developed by faculty, and facilitate the integration of raw data and pedagogy in teaching practice. To date, there has been anecdotal evidence of increased interest in publishing through TIEE, as authors now approach TIEE on their own and with more fully developed submissions. TIEE has also facilitated the professional development of faculty with a strong interest in pedagogy.

Challenges: Two major challenges in EcoEd DL’s development have been technological barriers that decrease website usability and low submission rates. To deal with these challenges, ESA plans to more
actively and strategically engage the existing leadership structure within the Society and to adopt a new cataloging platform that includes some interactive features. Technical and financial sustainability have been ongoing challenges for both EcoEd DL and TIEE, which are web-based and have been supported entirely through grants. Both projects have benefited significantly from faculty volunteers.

**Poster #175**  
**Category: C4**  
**Primary Project or Approach:** Promoting Institutional Change (Universities and colleges, departments, professional societies)  
**Institution:** Montgomery College, Rockville Campus  
**Presenter:** Barbara Hoberman  
**Email:** barbara.hoberman@montgomerycollege.edu  
**Field of Interest within Biology:** Molecular Biology & Biochemistry

**Goals & Intended Outcome:** The Biomedical Scholars Program promotes retention and success in the sciences for incoming community college students. It provides a seamless transition to college, ongoing peer support, academic support, and research internships. It positions students to transfer to four-year colleges as science majors.

**Methods & Strategies:** A Pre-matriculation Summer Bridge Program provides students with a college-level math course, a chemistry review and writing exercises. During the first and second academic years ongoing tutoring in math and chemistry and personalized advising is provided. A state of the art research internship occurs during the summer between the first and second years.

**Evaluation Methods & Results:** Success of the Biomedical Scholars Program is measured by comparing students to a peer group who have not had the benefits of the program. Measurable objectives are: a) Scholars will attempt and complete more science and math credits by the end of their first and second years; b) Scholars will earn a higher GPA than their non-program peers; c) Scholars will transfer to four-year institutions as science majors at a higher rate than their non-program peers; and d) Scholars will graduate with a baccalaureate degree at a higher rate than their non-program peers.

**Dissemination Activities & Plans to Disseminate:** The program design and data is shared at local and national conferences, at workshops addressing student success in the sciences, and at NIH/NIGMS meetings for program grantees. Additionally, the program has been used as the model for Montgomery College's FIPSE and S-STEM programs in engineering.

**Impacts of Project or Anticipated Impact:** Aggregated data has been accumulated for the first five years of the program. When comparing the scholars to their non-program cohort at the end of the second year of college: a) 80.8% of the scholars had earned 48 credits as opposed to 46.5% of the non-program cohort; b) the average GPA of the scholars was 3.05 as opposed to 2.77; c) 67.3% of the scholars had completed at least one calculus, 2 biology and two chemistry courses at the end of two years as opposed to 27.4% of the non-program cohort. The transfer rate for the program cohort is 84.6% as opposed to 61% of the non-program cohort.

**Challenges:** Failure to anticipate the large number of students for whom English is a second language required redesigning of the Pre-matriculation Summer Bridge Program to include ESL and remedial English courses. Additionally, based on feedback from the first class of Scholars, the Pre-matriculation Bridge was further redesigned to include a 25 hour non-credit chemistry review. One major challenge is tracking students after they transfer. Initially, scholars were tracked by personal contact and compared to the general transfer rate for the college. We now track the scholars and their non-program peer group who are following a similar academic track by using the National Student Loan Clearinghouse.
**Poster #179**  
**Category:** C4  
**Primary Project or Approach:** Promoting Institutional Change (Universities and colleges, departments, professional societies)  
**Institution:** San Francisco State University  
**Presenter:** Kimberly Tanner  
**Email:** kdtanner@sfsu.edu  
**Co-Presenter:** Nancy Pelaez, Purdue University; Michael Stevens, California State University, Stanislaus; and Kathy Williams, San Diego State University  
**Field of Interest within Biology:** Biology Faculty with Education Specialties

**Goals & Intended Outcome:** Many science departments are hiring Science Faculty with Education Specialties (SFES), scientists who take on specialized roles in science education within their discipline. Our on-going research efforts aim to identify and investigate SFES and their role in improving science education from within science departments.

**Methods & Strategies:** In our recently published research study on the SFES phenomenon (see Bush et al, Science, 322:1795-6, 2008), we identified SFES across the 23-campus California State University (CSU), the largest U.S. university system. Using snowball sampling and a validated survey, we completed a systematic, cross-disciplinary analysis of CSU SFES.

**Evaluation Methods & Results:** Our research showed that CSU SFES were found across all faculty ranks (28% Assistant, 31% Associate, and 41% Full Professors) and in multiple science disciplines (biology (34%), chemistry (24%), geosciences (14%), and physics (25%)). Two sub-populations of SFES were identified, those specifically hired as SFES (Hired-SFES) and those who transitioned to SFES roles (Transitioned-SFES) from their initial faculty roles. More T-SFES pursued basic science research, whereas more H-SFES applied for science education research funding. The majority (71%) of CSU-SFES reported spending about the same amount of time on teaching as their non-SFES department faculty, suggesting that SFES are not primarily teaching positions.

**Dissemination Activities & Plans to Disseminate:** Our SFES research findings were published in Science in December 2008 and have been presented nationally at multiple scientific conferences. Our SFES Collaborative Team -- comprised of six SFES at six universities -- is embarking upon a national SFES research study, as well as efforts to nucleate a national SFES community.

**Impacts of Project or Anticipated Impact:** The CSU-SFES research study has initiated conversations among scientists, educators, and policymakers about the SFES phenomenon, which appears to have emerged over the past few decades as an institutional approach to science education reform from within science disciplines. In addition, our research team has published a guide for science departments that can aid faculty in defining their goals in hiring an SFES and articulating scholarly, teaching, and service expectations (see Bush, et al, CBE: A Journal of Life Sciences Education, 5:297-305, 2006).

**Challenges:** Our CSU SFES research study documented that SFES exist as two subpopulations that are undertaking science education activities with similar expectations for scholarship as non-SFES but with less support. Although our data suggest increased hiring of SFES, the findings are also consistent with the possibility of high attrition among these positions, and the reasons for this need to be more thoroughly explored. Are SFES expected to undertake a range of activities that are beyond their formal training? Does lack of academic infrastructure to support SFES scholarly activities in science education present a barrier to their success? Finally, is the success of SFES and the SFES approach itself hampered by professional isolation?
Poster #168  
Category: C5  
Primary Project or Approach: Career Issues  
Institution: University of Arkansas  
Presenter: Mary Savin  
Email: msavin@uark.edu  
Co-Presenter: Susan Chapman, American Society of Agronomy  
Field of Interest within Biology: Agronomy, Soil, Crop and Environmental Sciences

Goals & Intended Outcome: To engage students and provide opportunities for students to demonstrate learning and involvement and to associate with the professional society.  

Methods & Strategies: ASA is trying to reach young people directly while they are students by having an active undergraduate program, but ASA is also trying to provide resources for teachers too.  

Evaluation Methods & Results: I am not sure, but I know ASA has had task force groups discussing and investigating objectives and strategies, and membership and participation at the undergraduate level is being promoted.  

Dissemination Activities & Plans to Disseminate: Brochures and articles for newsletter through the web, email updates, and in print. Activities at the national meetings.  

Impacts of Project or Anticipated Impact: Impact is to engage students and bring them into the applied life science disciplines.  

Challenges: Reaching students is a challenge. One way ASA is trying to reach students is by forming an Ambassadors program involving existing members who interact with students.
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