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Critical Conversations: The 2008 Biology Education Summit

SUSAN MUSANTE

Representatives from 44 scientific societies and biology education organizations converged in Washington, DC, for the 2008 Biology Education Summit, co-organized by the American Association for the Advancement of Science and the American Institute of Biological Sciences.

On 15 and 16 May, 77 invitees, selected for their ability to effect change in biology education, met in Washington, DC, for the 2008 Biology Education Summit. They came to hear updates from leaders in the biology education reform movement; discuss ways to move reform efforts forward; and share ideas, programs, and resources. The groundwork for this gathering was laid nine years ago at the 1999 President's Summit of AIBS (American Institute of Biological Sciences) member societies, where representatives proposed to make evolution the overarching theme of biology education, develop teaching resources, and generate undergraduate curricular models. They envisioned face-to-face meetings to promote these initiatives.

Gordon Uno, University of Oklahoma professor and current chair of the AIBS Education Committee, outlined a plan for an education summit that would be the equal of the President's Summit in bringing together those actively working to reform undergraduate biology education. The goal, according to Uno, was "to establish a long-term, collaborative national effort among biologists with experience in science education, so that they can better meet the immediate challenges of teaching biology and plan for future challenges that biology education programs will face." Yolanda George, deputy director of Education and Human Resources at the American Association for the Advancement of Science (AAAS), helped to realize Uno's vision in 2007 by securing funding through a National Science Foundation (NSF) subaward to AIBS.

The purpose of the 2008 Biology Education Summit was to gather input on the broad challenges to undergraduate biology education reform and to provide assistance and resources for societies to move forward with their own initiatives. Speakers shared best practices and led discussions on recruiting and retaining underrepresented minorities, electronic education resources, science education research and publishing, standards in undergraduate biology programs, evolution education, and the public understanding of science.



The 2008 Biology Education Summit gets under way with an introduction by Gordon Uno, summit organizer and AIBS Education Committee chair. Photograph: Oksana Hlodan.

Preparing students

During his introduction, Uno challenged the group to think about how to speed systemic biology education reform, to

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consider what a visionary statement about the future of biology education would look like, and to broaden the impact and use of best practices. Uno suggested that a modern curriculum must prepare students to answer the major questions in biology, give them skills to think and work across disciplines, and emphasize the use of mathematics.

AIBS President Rita Colwell, professor at the University of Maryland–College Park and former NSF director, spoke about critical scientific workforce issues in the United States today. The number of people entering the fields of science, mathematics, and engineering is dwindling, and workforce demographics remain virtually unchanged while the US population grows more ethnically and racially diverse. The scientific community, she said, has the capacity to increase diversity and attract more people to careers in science. "It is clear that the gatekeeper is mathematics," Colwell explained. Mathematics is a foundation for all sciences, and the advanced mathematical concepts currently taught at the middle- and high-school levels need to be taught earlier, according to current hypotheses.



Rita Colwell, former NSF director and current president of AIBS, described the factors limiting the scientific workforce and provided a context for the summit. Photograph: Carroll Photography.

Michael Lange, vice president at McGraw-Hill Higher Education Group, echoed Colwell, emphasizing the need to address mathematics in the summit discussions. He provided evidence from his own company's experience to illustrate the lack of student proficiency in mathematics. The company's biggest demand for textbooks, he said, is for a series of courses called developmental mathematics. "It's essentially middle- and high-school math taught at college level for no credit," said Lange. Community colleges in particular enroll many students who have to take this course multiple times before they qualify to take a math course for credit.

Another issue of importance to the American scientific community, Colwell said, is the high percentage of scientists with doctoral degrees who are foreign born, because dependence on a nonnative workforce is not sustainable: other countries have increased their financial commitment to scientific research and development and established highly competitive university programs, and are now actively recruiting students back into their own workforces. Colwell shared a conversation she had with the prime minister of China, who told her that China wants Chinese scientists to return to their homeland, and is offering returnees salaries that are competitive with US pay. This "reverse brain drain" makes the need to train new scientists here at home even more critical.

The University of Maryland–Baltimore County (UMBC) is a stellar example of an institution that has made a commitment to boost the number of underrepresented minorities in the sciences. Earnestine Baker, executive director of the Meyerhoff Scholarship Program at UMBC (*www.umbc.edu/Meyerhoff/index.html*), described a common misperception about the lack of diversity in the sciences—namely, that underrepresented minorities are not interested in careers as research scientists. The reality, she said, is that traditional undergraduate science programs do not retain students because they do not provide them with early research opportunities, and they fail to foster a collaborative atmosphere. UMBC recruits high-achieving students into the Meyerhoff program and supports them throughout their four-year undergraduate education. All Meyerhoff Scholars participate in an intensive summer bridge experience before their freshman year, which includes group bonding activities, field trips, workshops, and math and science courses. The program's success stems from early collaborative research experiences, financial support, study groups, graduate school guidance, and support by advisers and mentors.



Earnestine Baker and Teresa Mourad highlight issues related to recruiting and retaining underrepresented minorities in the biological sciences. Photograph: Oksana Hlodan.

The Ecological Society of America (ESA) program SEEDS: Strategies for Ecology Education, Development, and Sustainability (*www.esa.org/seeds*) implements similar methods

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Larry Allen, representative of the American Society of Ichthyologists and Herpetologists; George Middendorf, representative of the Ecological Society of America; and Alan Savitzky, member of the AIBS Board of Directors and representative of the Society for the Study of Amphibians and Reptiles, share ideas during the summit. Photograph: Oksana Hlodan.

to diversify the science workforce. Teresa Mourad, director of ESA's Education and Diversity Programs, shared key aspects of their program for underrepresented minority students who are interested in ecology. These include research fellowships, field trips, campus ecology clubs, mentoring at the ESA annual meeting, and an active support network. Mourad wants to collaborate with others interested in attracting underrepresented minority students into biology careers and to identify ways to help them see the benefits and rewards of such careers. "We must ask ourselves if we are serious enough about bringing a diverse population into the sciences," she said. "If so, then we need to find a way to work together."

New tools

Online social networking and electronic-based resources are increasingly being used to enhance student understanding and interest in biology. Claire Hemingway, education director for the Botanical Society of America, spoke about her organization's Planting Science program (*www.plantingscience.org*), in which students work together in classroom groups on open-ended, inquiry-based projects and then interact online with mentors to get feedback on their research. The program takes electronic resources a giant step beyond simply teaching content. "We are taking advantage of technology to bring people together who wouldn't normally have access to one another," said Hemingway. To gain a deeper understanding of the nature of science, students must delve into questions and communicate with others about their research, she said, adding, "The online learning community supports teachers and their students to think and work like scientists and also work with experts in the field."

Sam Donovan agrees that using technology merely as a vehicle to provide content misses an opportunity to revolutionize biology teaching and learning. Donovan, a biology professor at the University of Pittsburgh and associate director of the BioQUEST Curriculum Consortium, told summit participants that the convergence of new technologies, the



Education summit participants Kristin Jenkins (NESCent Education and Outreach program manager), Claire Hemingway (education director of the Botanical Society of America), Sam Donovan (associate director of BioQUEST Curriculum Consortium), and John Jungck (education committee chair for the Society for Mathematical Biology) discuss education initiatives. Photograph: Oksana Hlodan.

greater availability of online science resources, and a tech-savvy student population is creating exciting opportunities. "We have to think about what scientists are doing, how they are interacting, and how we can bring those resources and interactions together to engage students in the process of science." "Problem spaces" on the BioQUEST site (*www.bioquest.org*) provide a dynamic set of teaching resources connected with real science tools and research data for students to explore. The online materials are readily adaptable and give students experience doing what scientists do: identifying research problems, working to solve them, and convincingly presenting their research results to colleagues.

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Observatory networks such as the NSF-funded National Ecological Observatory Network (NEON; *www.neoninc.org*) are developing sensor networks with open-access data sets that will allow realistic forecasting about life on Earth at the systems and even biosphere levels. Carol Brewer, a biology professor at the University of Montana, said that our understanding of biological sciences is constantly being revolutionized by the new tools and methodologies being developed to observe and investigate life on this planet. The data sets will open up opportunities not just for the research community but also for the education community. "How ready are our students to use existing databases, let alone to interface with these new ones?" Brewer asked. It is critical, she said, to help students develop the skills they will need to be ready to interact in an increasingly interdisciplinary world, regardless of whether they will become biological scientists. Some may argue that such a broad focus will "dumb down" biology content. "Get over it!" Brewer said. "You don't need to be exposed to everything to be able to work in a discipline." Students need to know how to learn in a changing world, question, communicate, and collaborate, and Brewer suggested that the community look at existing interdisciplinary courses as models.

Insight into the effectiveness of interdisciplinary courses and innovative teaching approaches can be gained by conducting research on student learning. Diane Ebert-May, a botany professor at Michigan State University, urged summit participants to gather data on teaching outcomes, to move beyond wondering why students do not understand concepts in biology. "We need data about student learning," Ebert-May said, "to know whether the tools we are using make a difference." Certainly there are limitations to education research, she said, but anyone trained as a research scientist is familiar with limitations and will understand the methodologies. Ebert-May and her colleagues are working on the FIRST III Assessment Database (*http://first.ecoinformatics. org*), a repository for student assessment data funded by the NSF. "Science is driven by data, and education about learning science has to be driven by data," Ebert-May said. Data in the FIRST III database are described, archived, and searchable so that others can ask and investigate questions about student learning, analyze student outcomes, and modify their teaching practices.

Results of education research need to be disseminated so that others can learn what works. Charlene D'Avanzo, director of the Center for Teaching and professor of ecology at Hampshire College, is an editor for the online ecology education journal *TIEE: Teaching Issues and Experiments in Ecology* (*http://tiee.ecoed.net*). During a meeting of editors involved with the Biology Scholars Program (*www.biologyscholars.org*), she learned about the challenges common to all biology faculty who want to publish results of education research. Many struggle to find relevant references, connect with colleagues asking similar questions, put their research into context, or analyze their data. "Biology faculty need help with the practice of education publishing because they haven't been involved in the culture of education publishing," D'Avanzo said. She asked that societies provide professional development opportunities, and proposed the establishment of an intersociety committee dedicated to scientific teaching. "We have got to establish working groups across societies to address these fundamental issues," she said. "If we don't give people help who are gathering data and want to publish, they may not have motivation or time to do it."

Looking forward

Ensuring that faculty engaged in education research have support, that students learn contemporary skills and key biological concepts, and that coursework is not content-driven is a tall order. It may require a set of general guidelines, standards, or even accreditation for four-year biology programs. John M. Moore, professor of biology at Taylor University and president-elect of the National Association of Biology Teachers (NABT), pointed to a recent study of changes in biology courses over the past 15 years to highlight the need for such standards. "There has been a change in biology culture," Moore said, "but no standardization across majors curriculum, and no outcomes for a first year course."

Christopher D'Elia, a professor at the University of South Florida, challenged summit participants to consider accreditation as a solution. It could help create minimum program standards, high-quality facilities, routine assessment of student learning, greater opportunities for funding, and basic standards for becoming a biologist. D'Elia readily admitted, however, that none of these outcomes is guaranteed. He suggested a number of alternatives to reach similar goals and recommended that AIBS work with the NABT on their recently finalized "Guidelines for Evaluation of Four-Year Undergraduate Programs in Biology," which provide recommendations, requirements, and examples for improving faculty development, curriculum, equipment, technology, and outreach. Moore explained that the NABT is now field-testing the guidelines to learn how well they suit the needs of faculty and departments interested in self-assessment.

The NABT guidelines state that evolution is the unifying theory of biology and should be infused throughout the curriculum. The goal of a new project called Evolution Across the Curriculum (EvAC), led by Uno and Judy Scotchmoor and supported by the National Evolution Synthesis Center (*www.nescent.org*), is to develop tools and resources for educators to integrate evolution into their courses. Although evolution is often purported to be a central theme in textbooks and biology courses, Uno said, the topic is usually treated as a separate subject in the course syllabus. EvAC products will help educators teach biology in a contemporary way. "We do a great job of telling students what something is and what it does," Uno said. "We need to include how [it got] this way and how...we know that." His team wants to illustrate, with supporting evidence, how evolution plays a role in every aspect of biology. The team is looking for volunteers to try teaching in this manner and for suggestions for topics.

Several well-funded campaigns are specifically focused on undermining science education and challenging evolution.

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Jay Labov, of the National Academy of Sciences (NAS), spoke about the NAS's most recent project to counter these challenges: *Science, Evolution, and Creationism* (National Academies Press, 2008). The book emphasizes that evolution is a core scientific theory serving as the foundation of many areas of science. NAS has conducted significant audience research to learn what messages resonate with the general public. "The goal was to reach the many people sitting on the fence who really don't know what to believe," Labov says. "For the most part, people don't have a clue about what science is, what it isn't, and how scientists do their work."

One program dedicated to helping the public understand science—what it is and how it is done—is COPUS, the Coalition on the Public Understanding of Science (*www.copusproject.org*). "It is a growing peer network providing resources and connections to people all interested in the same goal," explained Scotchmoor, COPUS Steering Committee member and assistant director for Education and Public Programs at the University of California Museum of Paleontology. Scotchmoor and Sheri Potter, COPUS network project manager at AIBS, invited summit participants to join this grassroots, multidisciplinary coalition of over 220 organizations. Two current COPUS initiatives are the Year of Science 2009 (*www.yearofscience2009.org*), a theme-based, year-long celebration of science, and Understanding Science (*www.ucmp.berkeley.edu/understandingscience/index.php*), a new Web site with resources for those who wish to learn more about communicating science and teaching about the nature of science.

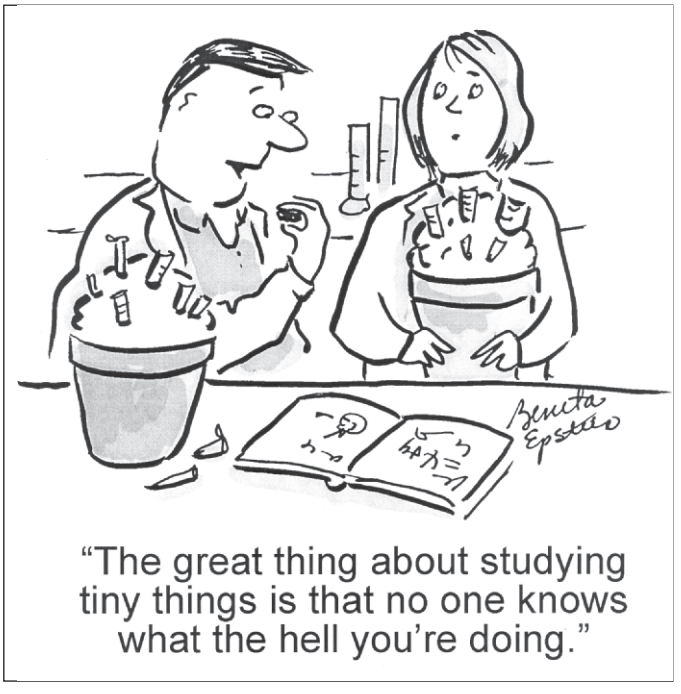
During the final hour of the summit, attendees had time to talk with their colleagues and determine the next steps needed to advance biology education initiatives through their societies. Jessica Hopkins, from the University of Akron, will recommend participation in COPUS to her colleagues in the North American Benthological Society to stimulate discussions about intersociety initiatives. Charles Bomar, from the University of Wisconsin–Stout, will write a column for the Society of Orthopterists' newsletter to generate interest for the ideas he gathered during the summit. Penny Bernstein, from Kent State University, and Jerry Wilkinson, from the University of Maryland, will present their colleagues in the Animal Behavior Society with a list of initiatives they wish to develop, including Web-based education resources and core concepts in animal behavior. Todd Carter, from Seward County Community College and president of the NABT, was glad to learn of different perspectives on common issues and will discuss with his NABT colleagues how best to leverage resources.

The AIBS Education Committee will review the NABT's guidelines and determine whether to recommend that the AIBS Board of Directors endorse them. The committee will also work with staff to seek funding to broaden the impact of AIBS's online education resources, establish working groups to address specific core issues discussed during the summit, facilitate meetings to allow significant face-to-face time for collaboration and professional development, and develop a communication network to support biology educators implementing innovative strategies and researching student learning.

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[The 2008 Biology Education Summit presentations are available online at *www.aibs.org/special-symposia/aibs_biology_education_summit.html.*]

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