Diversity & Democracy
CIVIC LEARNING FOR SHARED FUTURES
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Bellevue College

FEATURED TOPIC

Today's students face critical challenges that will require both global knowledge and scientific literacy. This issue of *Diversity & Democracy* examines the vital learning that can occur at the intersections of these strands of thought, where global learning provides a frame for scientific thinking and science forms the basis of global understanding.

ISSUE HIGHLIGHTS

Diversity & Democracy

AAC&U Association of American Colleges and Universities

Global Learning and Scientific Literacy at the Crossroads

SUSAN ELROD, executive director of Project Kaleidoscope, and **KEVIN HOVLAND**, director of global learning and curricular change—both of the Association of American Colleges and Universities (AAC&U)

"Global learning" is a term whose meaning continues to evolve, and higher education's stakeholders struggle to agree on a working definition. Most colleges and universities see themselves as global in some way or address globalization at some level, and the majority are trying to become more global in their approaches and institutional identities. The range of what they mean by "global," however, is wide and can include faculty research agendas, international student bodies, partnerships with institutions in other countries, and, of course, study abroad.

While the adjective "global" retains a broad array of meanings, there is growing agreement about the outcomes and goals—if not the methods and measures—of twenty-first-century education. Current debates about student learning have reached toward a consensus that bridges what is known about how students learn and what kinds of literacies and competencies students will need to be able to recognize, evaluate, and address complex real-world problems with local and global consequences (see AAC&U's LEAP Essential Learning Outcomes, for example). These debates provide a framework for describing global learning in practice even as higher education struggles to define it.

Imagining such practices was one of the primary goals of AAC&U's 2011 Annual Meeting, "Global Positioning: Student Success, Essential Learning, and the Currency of US Degrees." It was also the focus of the 2011 premeeting symposium, "Integrating the Sciences, Arts, and Humanities: Global Challenges and the Intentional Curriculum," cosponsored by Project Kaleidoscope and the Shared Futures initiative. This issue of *Diversity & Democracy* continues the conversations initiated at those events by focusing on the relationship between science education, student learning, and big global questions.

From Culture to Contextual Integration

What do students need to know about a world defined by interconnections and interdependencies? What skills will they need to navigate such a world? Working backward from these questions, what should the curricula look like if they are to provide sufficient opportunities for students to develop such knowledge and practice such skills? How can educators ensure that a global approach to student learning occurs not only in disciplines that focus on culture, but across the entire campus? What will science courses look like, both within the disciplines and in general education, if they are framed as global learning experiences? What will teaching across all disciplines be like if faculty members focus on integrating learning through application to real-world problems?

In this issue of *Diversity & Democracy*, Indira Nair, chair of the Shared Futures Global Learning Leadership Council, raises such questions in her exploration of

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ABOUT THIS ISSUE:

Science Education and the Big Global Questions: Learning with a Purpose

Among physics students, scientists, and historians, the anecdote is well known. J. Robert Oppenheimer, observing the first nuclear explosion at Trinity—named, he claimed, in obscure reference to the poems of John Donne—recalled these lines from the Bhagavad Gita: "I am become Death, the destroyer of worlds." Positioning this momentous scientific breakthrough within eastern and western canons, at the crux of poetry and religion, Oppenheimer traced the global arc of a technology that would have a truly global impact. Clearly, he knew the potential for consequences that were far from benign.

What is less clear is the effect Oppenheimer's echoing observation has had within physics classrooms, and in scientific teaching and learning more generally. His words beg the question of whether he foresaw the devastation his work would wreak halfway around the world. Did the complex ethical implications weigh heavily on him? To what purpose did he toil in creating new technologies—and to what end, more generally, does science advance? These are weighty and relevant queries, but within introductory science courses, they seem to receive little attention compared to the technical aspects of atomic energy.

Conversely, students who pursue these questions beyond the scientific disciplines may engage deeply with technology's potential impacts. But without basic literacy in the sciences, they cannot truly grapple with the choices that technology presents. Without basic understanding of the science of nuclear energy, for example, one cannot evaluate its risks and benefits to people and to the environment, in local and global contexts. What will the future look like if its leaders—today's college students—cannot make educated decisions about these topics?

If students currently spend more time exploring how science works than why we pursue it—or more time critiquing scientists' decisions than understanding the knowledge underlying them—one has to wonder what would happen if those priorities were more balanced. What if students more often studied science using the big global questions—of ethics, meaning, and human interconnectivity—as a framework for the nitty-gritty details of technical analysis? And what if they approached the philosophical questions of meaning and purpose with a deeper understanding of science?

This issue of *Diversity & Democracy* broaches these questions by exploring scientific pedagogies that are grounded in the twenty-first century's big global questions. Seeing interdisciplinary subjects like environmental sustainability and global public health as scaffolding for science teaching, it points to pedagogical models that allow students to develop scientific literacy paired with an understanding of global and ethical contexts, whatever their future majors or careers. An expansive understanding of science *and* its implications is necessary if higher education is to responsibly mobilize science's potential. We invite readers to consider our authors' efforts to teach science with purpose, clarity, and context, and to consider the implications for teaching and learning at their institutions.

—Kathryn Peltier Campbell, editor

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the "new literacies" that are "requisite to participation in a globally interconnected world." Lisa Gentile and Kathy Hoke of Project Kaleidoscope's Facilitating Interdisciplinary Learning project describe a curricular innovation at the University of Richmond that frames an introductory science course around inquiry about global problems. Additional articles focus on sustainability and public health, providing examples of places in the curriculum and cocurriculum where students are integrating multiple perspectives and applying their learning on the ground. By focusing on contextual integration, these articles force us as educators to broaden our understanding of global learning and to consider the implications of our most ambitious student learning goals for the curriculum and for faculty expectations.

The Evolution of Global Learning

A decade ago, when AAC&U queried its members about their definitions of global learning, our questions were most often forwarded to the offices primarily responsible for international education—in most cases meaning study abroad. Things have changed considerably in the years since. Global economic crises and climate change, avian flu, 9/11, and similar trends and events have focused greater attention on questions of the world's interdependence and interconnection. At the same time, campuses have spent more time and energy defining and assessing undergraduate learning outcomes in general education and in the majors. Attention to these topics converges on questions of purpose and outcomes, encouraging educators to reimagine the curricular and cocurricular pathways they provide for students to test their learning in the context of increasingly complex, real-world issues.

In their mission and vision statements, colleges and universities are increasingly linking definitions of high-quality education to the ability of their graduates to act as global leaders, stewards, and citizens. While institutions are translating these aspirations into a wide variety of learning experiences and curricula, we at AAC&U have noticed two related but distinct ways that globalization has captured the imaginations of higher education leaders.

The first focuses on global competition. Thomas Friedman and others are concerned with the relatively low number of science and engineering degrees awarded to US students. In a globally structured economy (or a "flat world," as Friedman describes it), US educational policies must be geared toward ensuring that US students are better prepared for participation in the interconnected and highly competitive global knowledge economy. Thus Friedman advises his daughters: "'Girls, finish your homework—people in China and India are starving for your jobs'" (2005, 279).

This is essentially a national security argument with an economic and educational focus. While the United States is falling behind in technical skills and entrepreneurial spirit, US students don't know nearly as much about the rest of the world as students in the rest of the world know about the United States. Plenty of evidence attests to American students' lack of interest in foreign languages and lack of basic knowledge of world history and geography. Consequently, it is not enough to simply encourage more students to become engineers. It is also necessary to rethink how those engineers are educated, focusing on content and pedagogy as well as completion rates. Without this broader approach, the number of US engineers may increase, but their success in the global knowledge economy will not.

The second strand emphasizes the unique opportunity that global interdependence offers students and educators to engage profound questions of personal and social responsibility. If Thomas Friedman is the champion of a competitively educated *global workforce*, philosopher Martha Nussbaum is the voice for an intentionally educated *global citizenry*. In *Cultivating Humanity: A Classical Defense of Reform in Liberal Education*, Nussbaum argues that "campuses are producing citizens, and this means that we must ask what a good citizen of the present day should be and should know." She identifies three capacities of the student prepared for global citizenship: "critical examination of oneself and one's traditions"; "an ability to see [oneself] not simply as [a] citizen[] of some local region or group but also, and above all, as [a] human being[] bound to all other human beings by ties of recognition and concern"; and narrative imagination, or the "ability to think what it might be like to be in the shoes of a person different from oneself, to be an intelligent reader of that person's story." Nussbaum concludes that "cultivating our humanity in a complex, interlocking world…. requires a great deal of knowledge that American college student rarely got in previous eras" (1997, 9–11).

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Science's Role in Educating for Humanity

Nussbaum's vision of education for global citizenship has deeply influenced AAC&U's Shared Futures initiative. As we described the initiative in 2001, Shared Futures puts "questions of diversity, identity, citizenship, and responsible action at the heart of global learning. This approach challenges students to explore the relational nature of their identities—identities that are variously shaped by the currents of power and privilege, both within a multicultural US democracy and within an interconnected and unequal world" (http://www.aacu.org/SharedFutures/). We are currently striving to find new language and develop new frameworks that retain these goals while avoiding the misperception that this humanistic approach is the only pathway to global learning.

Thus we are asking anew what role the sciences and notions of scientific literacy play in preparing students to address and participate in solving large global problems. We are not simply adding STEM (science, technology, engineering, and mathematics) disciplines to existing conversations about global learning that have already been framed by the humanities and social sciences. Instead, we are seeking common ground around complex global questions, opening spaces where faculty members and students can create richer opportunities to explore how the tools, perspectives, and insights of the arts, humanities, social sciences, and sciences might be brought to bear on solving problems. How will the resulting conversations shape the content we expect students to master and change the competencies we expect from all graduates? How will these conversations change curricular designs, and what kinds of faculty development will be required as a result?

These are some of the questions we began asking when AAC&U and Project Kaleidoscope (PKAL) joined forces in 2010 to advance and amplify work on improving undergraduate education in mathematics, the sciences, and engineering. PKAL brings to AAC&U deep expertise in creating experiential and engaging learning environments for undergraduate students in STEM programs. For example, PKAL's recent project on facilitating interdisciplinary learning (see http://www.aacu.org/pkal/interdisciplinarylearning/) explored the rich territory of interdisciplinary student learning outcomes and their assessment, as well as the issues in campus culture and leadership that need to be addressed in order to create more integrative learning experiences.

University of North Florida

As we work at these crossroads, we have found inspiration in the metaphor of the "trading zone," which framed the 2011 PKAL–Shared Futures symposium. Through our partnership, we find ourselves creating our own "trading zone"—a promising field of inquiry much like the ones that appear when faculty explore the languages, cultures, and expectations of their disciplines in an effort to better understand their strengths and assumptions. In the PKAL–Shared Futures trading zone, we are working collectively to help both faculty and students more effectively negotiate the boundaries between disciplines in order to more creatively apply knowledge in context. We continue to learn from one another and to enrich our understandings of global learning and scientific literacy.

The symposium and this issue of *Diversity & Democracy* are just two examples of a more comprehensive PKAL–Shared Futures effort to rethink what a twenty-first-century undergraduate degree should mean. Can higher education test that meaning not simply against the ability of graduates to get jobs and compete in a global economy (as important as that is) and not simply against expectations of ethical and compassionate citizenship (as important as those are), but against the ability of graduates to apply their learning to urgent problems that face the world? It's a challenge we are taking up together, and we invite you to join us.

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[SCIENCE EDUCATION AND GLOBAL QUESTIONS]

New Scientific Literacies for an Interdependent World

INDIRA NAIR, vice provost emerita, Carnegie Mellon University, and chair of AAC&U's Shared Futures Global Learning Leadership Council

As higher education becomes increasingly attuned to global interdependence, the task of preparing students to be responsible citizens and professionals becomes more complex. Colleges and universities have long provided general education designed to afford breadth beyond the expertise students gain in their majors. But students now need more clearly defined awareness and sensibilities that will help them make informed decisions about issues of global concern, such as environmental sustainability. They will need to develop capabilities to address these issues while also meeting the demands of functioning in a technological society where science and quantitative analysis are key to decision-making.

Decades ago, a "literate" person was one who knew the Western canon. Today, colleges and universities must move beyond that narrow framework to impart to students a set of multiple "new literacies": scientific, technological, ethical, environmental, and global. This set of literacies is requisite to participation in a globally interconnected world. In this article, I will briefly describe the evolution toward the concept of new literacies before exploring what scientific literacy in particular means for students.

From Literacy to Literacies

In announcing its Literacy Decade (2003–12), the United Nations (UN) acknowledged an expanded and pluralistic definition of literacy. Looking beyond the "three Rs," the UN recognized that "there are many practices of literacy embedded in different cultural processes, personal circumstances and collective structures" (UNESCO 2004, 6). Although based in an understanding of multiple cultural and social milieus, the UN's efforts focus primarily on comprehension of the printed word.

Literacy in this sense has long been necessary for individuals to function in the world. It has been key to communicating effectively, to understanding the order of social institutions, and to participating in public decision-making—in short, to surviving. According to Stromquist, "literacy skills are fundamental to informed decision-making, personal empowerment, [and] active and passive participation in local and global social community" (2005, 16).

Seven years after the UNESCO report, literacy has become a ubiquitous term, used to express a wider range of competencies than those concerned with language. In this expanded view, literacy is no less important to survival. Take scientific literacy as an example: individuals need it to function in a technology-dominated society. But society also needs individuals who have it so they can take ethical and informed action, understand the global and local implications of their actions, and change those actions if the outcomes are not desirable.

Defining Scientific Literacy

Shifts in the idea of literacy have arisen in tandem with pressing problems whose solutions require competencies heretofore entrusted to experts. In today's world, it is not enough for experts to hold specialized knowledge: all citizens must have some literacy in a range of subjects to inform their decision-making and personal actions. When considering these new literacies in the context of higher education, one fundamental question is: What does one need to know, and how does one act if one is literate in a particular area?

Scientific literacy is different from expertise in science. It is a functional literacy consisting of the ability to find relevant scientific information as needed, to understand basic meanings, and to ask the right questions. In short, it means being able to use information. Scientifically literate people are able to discriminate between information that is relevant and irrelevant, useful and useless, and they understand what constitutes the right degree of precision.

The National Science Education Standards developed by the National Academy of Sciences (1996) speaks to this understanding of literacy. However, it also includes the requirement that "a [scientifically literate] person ha[ve] the ability to describe, explain, and ***predict*** natural phenomena" (22, my emphasis). Predictive ability calls for formal expertise and understanding that not everyone can practically achieve. Thus educators should ask, what is the minimum set of basic principles in each discipline that would constitute literacy? Pedagogy geared toward literacy should begin with this question. Without it, curricular reform will rest on misconceptions that thwart educational attempts.

Teaching for Scientific Literacy

At present, colleges and universities generally teach scientific literacy as a weakened version of teaching for expertise, by using analogies too vague to be of use, or by requiring nonscience majors to take introductory courses designed for majors. None of these approaches yield scientifically literate students who are able to invoke scientific knowledge as and when needed.

In addition, this kind of teaching often undermines students' motivation or allows them, in proverbial terms, to "not know that they do not know."

What are some general features of teaching and learning for the new literacies, and for scientific literacy in particular? First, learning should be connected to students' lives and placed in context. Yet science, as expressed through formalism, aims at general principles abstracted from observation. It is often taught in ways that reflect this—by introducing students to mechanics through the general principle of Newton's laws, for example. In this educational model, connections to lived experience appear only as applications of principle. In contrast, the second general feature of teaching for scientific literacy suggests that educators should present laws as derived from daily experience, and hence as useful.

Make connections via interdisciplinarity, and motivate students via context-setting: These are not new ideas, although they have long been marginalized in science. Under the influence of Francis Bacon, science increasingly became a tool for technical achievement—in Bacon's words, for the "endeavor to establish and extend the power and dominion of the human race over the universe," an ambition he called "wholesome and noble" ([1819] 1960, 29). As science developed in this direction, it became increasingly divided into disciplines. Numerous authors have pointed out that this approach has affected pedagogy and alienated students from science. But as science increasingly becomes a tool for humanity rather than a tool for power—a shift on which human survival arguably depends—calls for interdisciplinarity are becoming louder.

The Need for Interdiscliplinarity

The shift to interdisciplinary teaching changes the motivation for learning science. Rather than positioning science as a tool for experts to achieve technical control, interdisciplinary teaching and learning posits science as a tool for everyone to serve humanity. An invitation to do science for this purpose can be a significant motivator to students who otherwise see science as irrelevant to their lives and leave the science pipeline altogether (Seymour and Hewitt 1997).

Great educators like Alfred North Whitehead articulated similar themes early in the twentieth century. In the introduction to *Aims of Education* (1927), Whitehead delineated three fundamental stages of learning science: ***romance***, ***precision***, and ***generalization***. Too often, twenty-first-century educators teach science by inverting these stages—introducing students to the subject matter through generalization. With this approach, many students never experience the romance, never become emotionally involved with the topic or subject area, and thus never internalize or own the knowledge.

Educator Joseph Novak pointed out that "the central purpose of education is to empower learners to take charge of their own meaning-making. Meaning-making involves thinking, feeling and acting, and all three of these aspects must be integrated for significant new learning, and especially for new knowledge creation" (1998, 13). Marcia Linn and colleagues refer to this as knowledge integration, "a dynamic process where students build connections between their existing knowledge and the curriculum content" (Slotta and Linn 2000, 195).

One conundrum of teaching for literacy arises in the context of knowledge integration. Education for the various literacies is often relegated to the general education curriculum, where it is seen as less important than the deep learning that occurs in the major. As a result, the total time and attention given to developing general literacies is less than that devoted to the major. Yet this type of learning is about developing sensibilities and habits of mind that should eventually become second nature—a process that requires time and practice. Most people who read and write well learn to do so by using these skills regularly, for multiple activities where they practice implicitly all the time. The same should be true of all literacies students develop while in college. Practice should thus be embedded not only in general education, but also in the major—even if doing so requires faculty to move beyond their comfort zones.

A Pedagogical Approach

By grounding science in concrete contexts and relevant situations, educators can provide the romance and encourage the meaning-making that will keep students interested. So what is teaching that begins with these assumptions like?

I taught a course modeled on these assumptions for teaching scientific literacy for all students. The course was called Science and Technology for the Environment, and it used the environment and human relationships to it as a basis for teaching scientific and technological principles for daily decision-making. The course followed a problem-solving approach, invoking basic scientific principles and technical skills as the topics addressed required them. The approach conceived of the environment as composed of different systems—ethics, atmosphere, energy, materials, health, institutions—and included assignments, exercises, and projects relevant not only to the environment and but also to students' daily lives (for more about our pedagogical frameworks and course material, see http://telstar.ote.cmu.edu/environ/m2/s3/index.shtml).

To keep connections and context in sight, I regularly used concept mapping as a tool. In addition to encouraging

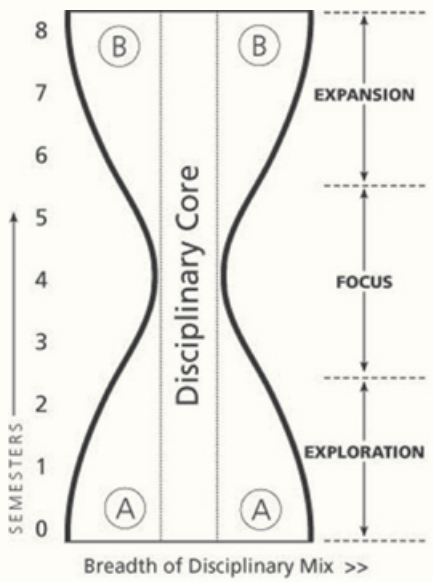
systems thinking, concept mapping can reveal students' preexisting misconceptions. As educators such as Hestenes and Mazur have shown, when students' conceptual frameworks are erroneous, they continue to build around those frameworks (Halloun and Hestenes 1985; Mazur 1997). Identifying and correcting misconceptions explicitly is a powerful learning practice.

When colleagues and I assessed students' learning and their ability to apply it, nonscience majors showed significant gains. They emerged capable of asking the right questions when faced with a situation involving environmental decision-making (Nair, Jones, and White 2002).

The Hourglass Model

Science teaching geared toward building expertise often starts with a sequential progression from theoretical knowledge to applied problem solving. This may be effective for students who are committed to science and will have extended opportunities for future cumulative learning. But teaching for literacy among nonscience majors requires a different approach.

Figure 1. Hourglass Curriculum Model



At Carnegie Mellon, we developed the "hourglass model," a scheme for maintaining depth while attaining breadth (see figure 1). This model may be an instructive framework for teaching that accomplishes both. The central cylinder represents the ***disciplinary core***, which extends as required by the students' major course of study.

Exploration occurs early in the students' educational careers and introduces the romance of Whitehead's model. This stage (marked as "A" in the diagram) provides exposure to the "big questions"—of science, environment, and ethics—in the form of interdisciplinary experiences such as seminars and projects that emphasize finding the right questions rather than solving problems. Students face multiple perspectives and solutions, consider real-world constraints and challenges, grapple with scientific uncertainty and incomplete knowledge, and practice making choices and decisions.

At the midpoint of the hourglass is ***focus***, a stage that is narrower in disciplinary range and concentrates around the major to build depth in knowledge and skills (while still keeping integration in mind). Toward the end of the undergraduate experience, the focus of study widens again to ***expansion*** (marked as "B" in the diagram) as students apply and exercise the skills they gained by studying disciplinary content and reflecting on their worldviews and professional obligations.

Real-World Learning for Real Application

Carnegie Mellon's models argue for introducing students early to interdisciplinary thinking, problem formulation, and the habit of grappling with complexity and ambiguity. In the context of acquiring new literacies to address vital problems, these practices can be empowering to students. As their studies progress, they develop disciplinary depth while continuing to hold earlier interdisciplinary questions in mind. As their undergraduate years come to an end, students revisit the questions they encountered at the beginning, this time applying their disciplinary expertise with greater mindfulness of complexity and ambiguity. This approach to science literacy education is valuable for science majors and nonscience majors alike as they prepare for real-world settings where people from all disciplines collaborate to solve the world's most pressing problems. Courses where students from all majors model this approach can be the best tools for introducing all literacies to all students.

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[SCIENCE EDUCATION AND GLOBAL QUESTIONS]

Public Health Learning Outcomes for All Undergraduates

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> "Public health is the science and art of protecting and improving the health of communities through education, promotion of healthy lifestyles, and research for disease and injury prevention." (http://whatispublichealth.org/)

Public health focuses on protecting the health and well-being of entire communities, from small towns to large countries to the global population. In 2003, the Institute of Medicine (IOM) recommended "that all undergraduates should have access to education in public health." The IOM's rationale was based on the premise that public health is an "essential part of the training of citizens" and that "[p]ublic health literacy…is an appropriate and worthy social goal" (Gebbie, Rosenstock, and Hernandez 2003). Indeed, advocates of public health education believe that it prepares students to contribute to the health of the public through positive decision-making and constructive action in personal, professional, and civic arenas.

Despite the strong rationale for widespread access to public health education, formal education for public health has long been centered at the master's level, with students coming from a variety of undergraduate and professional backgrounds. Nevertheless, undergraduate public health majors and minors now exist in many two- and four-year institutions. In fact, Karin Fischer and David Glenn identified public health as one of five college majors on the rise, with bachelor's degrees doubling from 2003 to 2007 (2009), and an analysis by the Educated Citizen and Public Health initiative showed public health to be a growing presence in undergraduate education (Hovland et al. 2009).

In response to increased student interest, institutions have sought guidance on optimizing the format and content of undergraduate public health education. At the same time, new courses and programs of study are engaging faculty across disciplines and fields in collaborative work connected to undergraduate general education or to various majors or minors. Public health topics facilitate, and indeed require, such integration.

The IOM recommendation and the explosion of public health on college campuses have jump-started several activities:

- the Association of American Colleges and Universities' (AAC&U's) Educated Citizen and Public Health initiative, which aims to advance public health education in undergraduate curricula (http://www.aacu.org/public_health/index.cfm)
- the Association for Prevention Teaching and Research (APTR) and AAC&U's "Recommendations for Undergraduate Public Health Education," which features a series of introductory courses in public health, epidemiology, and global health (Riegelman and Albertine 2008)
- the American Public Health Association's policy statement on "The Integration of Core Public Health Education into Undergraduate Curricula" (http://www.apha.org/advocacy/policy/policysearch/default.htm?id=1390)

Subsequent to these initiatives, the Association of Schools of Public Health (ASPH), in close collaboration with AAC&U and APTR, began a process to craft a model of public health learning outcomes that could be made available to all undergraduate students. The model is geared toward educating citizens who know about and are able to promote public health both locally and globally to eliminate health disparities in populations around the world. This article presents the results of the ASPH-led Undergraduate Public Health Learning Outcomes Development Project.

Enhancing Public Health Literacy

> "Both arts and sciences and public health should share in fostering and developing an educated citizenry." (Riegelman and Albertine 2008)

In 2009, ASPH partnered with AAC&U and APTR, combining their efforts to ensure that all undergraduates have opportunities to develop basic public health literacy. ASPH, AAC&U, and APTR, as well as the Centers for Disease Control and Prevention, invited representatives from both public health and liberal arts and sciences disciplines to join a leadership group that would define and drive the project. The process has engaged over 125 individuals to date.

The leadership group chose the framework of AAC&U's Liberal Education and America's Promise (LEAP) initiative to guide the development of undergraduate public health learning outcomes. By following the LEAP paradigm, the project team discouraged disciplinary silos and enabled participants to think broadly about the knowledge, skills, and attitudes necessary for public health literacy. Furthermore, the LEAP philosophy "support[s] the integration of public health education into general and liberal education with an aim to produce an educated citizenry" (Albertine 2008).

The first three LEAP domains align beautifully with the aims of public health education:

- Knowledge of Human Cultures and the Physical and Natural World (in this case, as related to individual and population health)
- Intellectual and Practical Skills
- Personal and Social Responsibility

For each domain, a core workgroup was tasked with identifying and specifying learning outcomes. Each core workgroup consisted of ten faculty members from universities across the United States, representing both public health and the liberal arts and sciences. Each group had two cochairs—one from public health and one from the liberal arts and sciences—who oversaw all activities. In addition, each domain had a resource group of over thirty academics who provided "reality checks" in response to emerging recommendations that the core workgroups drafted.

To reach consensus about learning outcomes across all three domains, the workgroups used an online modified Delphi survey process with three rounds. After each round of the survey, the core workgroup discussed the results and decided which draft learning outcomes would advance to the next round. Only the core workgroups responded to the first round, while the resource groups participated in rounds two and three. The overall response rate for all three surveys was 90 percent. On completing the surveys, the core workgroups presented selected learning outcomes at a model integration meeting attended by leadership group members and domain cochairs. The goal of the integration meeting was to bring cohesiveness to the model.

In developing the learning outcomes, the core workgroups referred to Bloom's Taxonomy to ensure that they included both cognitive and affective learning outcomes. The workgroups also assessed the draft learning outcomes to understand the level of the behaviors—from the simplest (knowledge) to the more complex (application, evaluation)—that were emerging. Because the learning outcomes were targeted for all undergraduates across all majors, lower level categories predominated.

The leadership group used the fourth and final LEAP domain, Integrative and Applied Learning, to identify the best instructional methods and learning practices for introducing and integrating public health content. All core workgroup members from domains one, two, and three provided input about domain four, which emphasizes student-centered learning over more traditional faculty-focused modes of teaching and assessment.

Public Health Learning Outcomes

Beginning with an initial slate of 394 proposed learning outcomes, the project team developed a final list of thirty-four recommended learning outcomes across the first three domains. These outcomes represent what all undergraduates, as educated members of society, should know and be able to do to promote their own and their communities' health. The concepts and skills can be integrated into both curricular and cocurricular learning opportunities. The list is neither comprehensive nor prescriptive. Instead, it illustrates the myriad ways public health contributes to quality of life locally and globally, while also facilitating adoption of the LEAP model in undergraduate education. In the long term, education geared toward these outcomes will promote a healthier citizenry empowered with the basic knowledge, skills, and attitudes to assist in eliminating health disparities in populations around the world.

The thirteen learning outcomes for the first domain, Knowledge of Human Cultures and the Physical and Natural World as it Relates to Individual and Population Health, encompass a wide variety of topics relevant to the humanities and sciences. A few outcomes focus directly on public health knowledge, including its definition, governmental roles, and key milestones in the field's development. Others point to developing an appreciation of community collaborations and an understanding of how diverse demographics within a community influence health. The outcomes encourage comparisons of certain factors at the local, national, and global levels: environmental hazards, risk factors for infectious and chronic diseases, and leading causes of death. They include valuing the relationships between human rights and health, science and technology and health, and medical and public health services and health. A learning outcome unique to this domain is to identify reciprocal relationships among literature, the arts, and public health.

The ten learning outcomes for domain two, Intellectual and Practical Skills, focus on understanding health information and data, and the methods of discovering and investigating related evidence. They include appreciation for the multiple determinants of health and for the interconnectedness of physical, social, and environmental aspects of community health, such as the impact of policies, laws, and legislation. The domain is rounded out with practical skills: research, analysis, teamwork, and communication.

The eleven learning outcomes in domain three, Personal and Social Responsibility, range from endorsing prevention and promoting healthy individual lifestyle behaviors to participating in community engagement for promoting public health, whether through active involvement in health promotion programs or in the political process. Ethics and social justice are included in this domain, focusing on the space where an individual's rights and preferences converge with the greater public good. Diversity is an element of domain three, appearing through

the outcomes of valuing multicultural perspectives and collaborating with others from diverse backgrounds.

Student-Centered Integrative Learning Methods

How can faculty best ensure that these learning outcomes are integrated in undergraduate curricula across the breadth of students' education? Public health is a versatile topic that relates to many subjects in many different ways. Domain four suggests methods for incorporating or integrating the learning outcomes into general education or discipline-specific courses, into cocurricular and experiential learning opportunities.

Workgroup members provided examples of high-retention and high-impact educational practices that would apply to specific learning outcomes. The model suggests the wide array of possibilities for incorporating the outcomes in a variety of undergraduate learning opportunities.

Table 1 illustrates how particular integrative learning methods can encourage specific learning outcomes.

Future Steps

Formal faculty development will be essential for suffusing the model across the curriculum. While the project provides examples for faculty seeking ideas about how to integrate public health into their teaching, the challenges of engaging faculty and developing their public health knowledge are topics for further exploration.

Beyond the plan for facilitating learning for citizens educated in public health regardless of college major lies the need to define academic benchmarks for undergraduate public health majors and minors. With the rise in undergraduate public health programs comes growing interest in clarifying the distinctions between undergraduate study in public health and the Master of Public Health degree. ASPH currently has a set of competencies for the Master of Public Health degree (http://www.asph.org/publication/MPH_Core_Competency_Model/index.html) and is beginning to create a competency model for undergraduate public health majors and minors. The goal of identifying undergraduate competencies accords with Healthy People 2020's national objectives for improving the health of all Americans, including the new objective to "[i]ncrease the proportion of four-year colleges and universities that offer public health or related majors and/or minors which are consistent with the core competencies of undergraduate public health education." As ASPH develops undergraduate competencies, it will also review the competencies for the master's degree. ASPH is planning to correlate the two projects to ensure the development of a well-articulated learning ladder for public health education.

For more information, visit www.asph.org/competency.

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Table 1. Correlating Learning Outcomes and Learning Methods

Domain No.	Outcome No.	Outcome Description	Integrative Learning Method
1	1	Appreciate the role of community collaborations in promoting population health	Team-based service project with a local health department to develop a campaign promoting smoking cessation
2	6	Communicate health information to a wide range of audiences using all types of media	Joint course exercise with journalism students to develop a multimedia public information campaign promoting influenza vaccines for senior citizens
3	4	Outline individual and community preparedness considerations regarding health emergencies and public disasters	Interactive seminar with a state director of public health preparedness sharing local community disaster management planning initiatives

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[SCIENCE EDUCATION AND GLOBAL QUESTIONS]

The Prairie Project: Faculty Development for Global Sustainability Education

■ **JIM ZAFFIRO,** professor of political science and coordinator of Global Sustainability Education, Central College

Today there is an urgent need to provide global sustainability education to all college students through a curriculum that is integrative, transdisciplinary, and addresses all three dimensions of sustainability: ecological integrity, economic equity, and social justice. To accomplish this, colleges and universities need action plans for training and supporting faculty members and staff as they work to give students the tools they will need upon entering the workforce, assuming leadership positions in their communities, and encountering complex, interconnected problems on a scale never before faced by humans.

Place-based global education is one key to a sustainable future. Success in providing this kind of education means that colleges and universities need to invest in, develop, and support educational resources, especially human ones. Central College made such an investment when it established the Prairie Project (PP), a faculty development opportunity. The project aims to create and nurture transdisciplinary learning communities of colleagues committed to helping each other develop strategies and activities for infusing global sustainability across the curriculum.

Place-Based Education

Central College is situated in the heart of what was once the central Iowa tall grass prairie bioregion. In 1853, the school was founded in Straw Town, Iowa (now known as Pella), where the grasses were said to be so high that one could barely see a rider sitting on a horse above them. Today less than one-tenth of one percent of the original Iowa prairie remains. With this history in mind, Central College's researchers are working, in the words of visionary perennial polyculturalist Wes Jackson, to "consult the genius of the place" (2010, 146) through a variety of research projects. These include prairie restoration work at Central's Carlson-Kuyper Field Station (a former farm) and through the Prairie Biomass Project, a new long-term research project conducted jointly by the biology and environmental studies departments.

This commitment to sustainability in research, combined with Central's twenty-year leadership in sustainable campus operations, has led Central faculty to rethink the curriculum as well. Central's mission and vision have provided the key connective tissue for that work.

Vision: "Central College will be a sustainable bridge to the future."

Mission: "Central integrates career preparation with the development of values essential to responsible citizenship, empowering graduates for effective service in local, national, and international communities."

In the early 2000s, students and faculty began seeking new ways to align the academic program with the sustainability and service commitments expressed in these statements. This momentum crested in November 2008 when the faculty voted unanimously to add a global sustainability component to our common core curriculum. Now all Central students (rather than a self-selected few) encounter sustainability in academic experiences that directly relate to their majors and career paths.

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But implementing a new requirement is more than a matter of adding it to the formal curriculum. In order to build infrastructure to support the change, the new office of Global Sustainability Education developed the Prairie Project, which offers professional training, curriculum development opportunities, resources, and support for faculty creating new and redesigned courses with significant sustainability content. The PP experience emphasizes the value of connecting and collaborating with colleagues across the disciplines, as well as with community partners. It facilitates community-based learning and other action-based pedagogies in order to integrate sustainability across the curriculum.

Community-Building

In May 2010, Central College successfully launched the Prairie Project's first Sustainability Education Learning Community with an intensive three-day workshop based on the Association for the Advancement of Sustainability in Higher Education's (AASHE's) Sustainability across the Curriculum Leadership Training Workshops. The planning team had originally anticipated twelve to fifteen participants, but demand exceeded expectations. To ensure that no one was left out, the group decided by consensus to reduce

each participant's stipend (funded by the president's office) in order to accommodate everybody. Ultimately, twenty-one colleagues—nearly one-fifth of Central's faculty, representing a dozen different academic programs and departments—joined the PP community.

With the importance of place in mind, I opened the first day of the PP workshop by asking participants to consider two questions:

- How is a liberal arts college like a prairie?
- How is sustainability education like prairie restoration?

The responses were creative and even profound. Participants examined how global and local communities of all varieties are connected, and how every place has intellectual, spiritual, social, and cultural dimensions that define its role within ecological communities.

Political sociologist Robert D. Putnam describes trusting communities as "breeder reactors" of social capital, innovation, and positive change. He advises community builders to nurture "networks that intersect and circles that overlap [to] reinforce a sense of reciprocal obligation and extend the boundaries of empathy [for the purpose of] creating virtuous circles of human connectivity" (2003, 289, 270). Sustainable communities foster connections based on deep bonds of respect and care. They are dynamic, welcoming environments, with different people contributing gifts of time, talent, experience, ideas, and resources.

Facilitating Ongoing Conversations

During the initial workshop, PP participants worked in collaborative pairs and small groups to share approaches and resources. They discussed ideas, participated in hands-on curriculum design activities, and forged ongoing partnerships with colleagues. By the end of the workshop, participants were already well on their way to finding new models for teaching and learning about sustainability within existing courses or through new curricular offerings. Participants developed and shared new assignments and learning activities. They also made new connections with community partners interested in helping them incorporate sustainability into the curriculum through community-based service learning and place-based, hands-on "learning by doing."

Central College is situated in the heart of what was once the central Iowa tall grass prairie bioregion. Today less than one-tenth of one percent of the original Iowa prairie remains. (Photo by Tonia Bleam)

One of the project's most valuable outcomes is the ongoing conversation between faculty from diverse disciplines about how they have incorporated sustainability into their teaching and how their students and colleagues are responding. Participants reconnected for a half-day follow-up workshop before the start of fall classes in late August, and again in December in front of a roaring fire and a table full of homemade desserts. In March 2011, the group gathered to discuss a common reading, James Farrell's *The Nature of College* (2010). These lively discussions are likely to continue well beyond the official end of the first PP in May 2011.

As a result of the project, Central has already gained several new courses in various disciplines, including Germany and the Environment (modern languages), Biomimicry (biology), Literature of Peace and Social Justice (English), Environmental Chemistry (chemistry), Economics of Sustainability (economics), Elementary Science Methods (education), Sustainability in Chinese and Japanese Cultures (history and Asian studies), People and Land of South Louisiana (political science), Community, Consumer, and Global Health (exercise science), and Doctrines and Ministry (religion). More courses with a sustainability focus are being developed for the 2011–12 academic year.

Looking Toward the Future

Planning is currently underway for the second iteration of the Prairie Project. As the project expands, the planning team envisions creating dynamic bioregional networks of integrated teaching, learning, and service communities dedicated to nurturing welcoming and sustainable partnerships. As more and more learning communities are created and connected over time, we hope that such initiatives will send ripples across higher education with powerful multiplier effects. With more Prairie Projects, higher education can lead—as it must—in addressing the challenges of creating a more sustainable future.

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[SCIENCE EDUCATION AND GLOBAL QUESTIONS]

Beyond International Competition: Diverse Perspectives and Scientific Discovery

LORELLE L. ESPINOSA, director of policy and strategic initiatives, Institute for Higher Education Policy

Attention to America's investments in science, technology, engineering, and mathematics (STEM) has perhaps reached its highest level since the famed Sputnik movement. As reflected in his proposed budget for 2012, President Obama has made US advancement in scientific fields a national priority for global competitiveness and economic health. Likewise, the secretaries of Education, Labor, and Energy, as well as leadership within the National Science Foundation and the National Institutes of Health, have all espoused the importance of STEM as a mechanism for competing in a global scientific marketplace, supporting national security, bolstering the US economy, and maintaining the health of America's citizenry. Yet often lost in this competitive message is the inherent value of diverse perspectives in our nation's laboratories and classrooms and the importance of collaboration across international boundaries.

> The focus on competition is ironic, since the very core of scientific discovery and engineering innovation exists in groups both small and large.

The Importance of Diverse Perspectives

The argument for diverse perspectives in STEM originated with the second-wave feminist movement (from the early 1960s to the late 1970s). Ruth Bleier, Sandra Harding, Donna Haraway, Sharon Traweek, and other feminist scholars painted a disturbing picture of the scientific community as an intellectual environment dominated by elite white men. They documented a scientific culture that was androcentric, ethnocentric, and absolutist. It is thus not surprising that many women were discouraged from studying STEM, and that those who persisted and entered scientific fields confronted attitudes, behaviors, and social constructs that proved incompatible with their active participation in the scientific community—an unfortunate phenomenon that still exists today.

Feminist scholars also chronicled the discriminatory *practice* of science. By the 1980s and 1990s, scholars such as Helen Longino (an American philosopher of science) were arguing that claims to objectivity—the hallmark of empiricism—could not be maintained without recognizing the social and cultural values that influence scientific practice. That is, the manner in which scientific questions are posed (who does the asking?), studied (who does the research?), reported (who tells the story?), received (who is the audience?), and supported (who provides the resources?) deeply affects the nature of the "objective truths" that science reveals.

Feminist scholars have often pointed to the birth control pill as a classic example of scientific application that directly affects the lives of millions of women, yet continues to escape the attention of researchers. Over fifty years have passed since the development of oral contraceptives, and yet the Food and Drug Administration remains unaware of their long-term effects. Of course, there are many reasons (financial, political, and market-driven) that certain treatments and diseases go understudied despite their impact on broad segments of the world's population.

Yet my point is this: scientists' perspectives necessarily influence scientific inquiry and the ways in which diverse national and global populations benefit from scientific innovation. It is necessary to ask, if more women had been directly involved in scientific inquiry over the past fifty-plus years, would the oral contraceptive market be different today, and would more be known about these drugs' long-term health effects? Likewise, how would scientific inquiry change if the scientific community included more perspectives from traditionally underrepresented groups? Would technology be more accessible to inner-city and rural communities? Would investments in biomedical research address a wider range of health problems facing the United States and the world?

What Is at Stake

As producers, users, and consumers of scientific products and knowledge, we must ask ourselves: what is the purpose of science? Is it to advance the health and well-being of our nation's citizenry? Is it to protect the natural resources of our planet, while also sustaining diverse lived environments, from Montana to inner-city Chicago, from rural Africa to Sao Paulo, Brazil? Is it to work across resource-rich and resource-poor countries to ensure an equitable distribution of food and energy? Is it to make our day-to-day lives easier and more enjoyable? Is it all of these

things? No matter what one perceives as the benefits of scientific research, I would argue that diverse perspectives matter more today than ever before.

From a global perspective, even the most geographically distant countries are growing ever closer to one another—not literally, of course, but economically and intellectually. Technological advances have made more transparent the interdependency of global markets and have quickened the pace of intellectual capital's delivery. Our global community, despite the challenges of cross-cultural communication, is itself of great benefit to STEM fields for a number of reasons, including this one: the diversity of thought available through international collaboration. Yet there is a balance that needs striking. It lies somewhere between competitiveness and inclusivity. And it is a balance that the United States has not quite achieved.

Adelphi University

Ironies and Tensions

The administration's emphasis on competition—communicated via competitive grant programs at the K–12 and higher education levels and for independent researchers and institutions—promotes innovation by way of necessity (that is, by rewarding innovative ideas with the monetary prizes that are necessary for research). Undergraduate STEM students, too, know competition well. They face it in first-year math and science courses, especially at top-tier research institutions where professors often practice weed-out techniques at the expense of students' confidence and potential success.

This focus on competition is ironic, since the very core of scientific discovery and engineering innovation exists in groups both small and large. While some STEM fields (for example, mathematics) continue to rely on individual discoveries, cross-disciplinary collaboration is necessary in most if not all emerging fields—including materials science, nanotechnology, biotechnology, and clean energy technologies.

Competitive atmospheres are also revealed as counterproductive in light of what we know about the way diverse populations learn. Higher education literature has shown that competition between students in the STEM classroom often contributes to a tense climate for women, who tend to value learning environments that promote relationship-building and community involvement (see Belenky et al. 1997). Such an atmosphere also makes transitioning to the science environment more difficult for first-year students from traditionally underrepresented racial and ethnic groups (see Hurtado et al. 2007).

A final tension exists in STEM departments with large international populations. STEM faculty often favor doctoral students from countries with stronger math and science programs than those in the United States (and if recent Organization for Economic Cooperation and Development reports are any indication, a number of these exist). While this approach may benefit individual faculty members and their research trajectories in the short term, it can be counterproductive to investments in America's STEM talent, particularly since most foreign students return to their home countries after receiving their degrees. This is not to say that universities shouldn't admit foreign students, but that admissions committees should pay attention to the holistic well-being of the department and the overarching field. In other words, they should aim for a balance of perspectives, both international and domestic.

Final Thoughts

Without crosscultural collaboration in the United States and around the globe, we cannot expect to make progress in environmental sustainability, public health, and other pressing scientific challenges that our country and world face. Within American higher education, this means creating and sustaining a diverse pipeline of US talent at each level of STEM education, while also inviting perspectives from abroad. Without this balanced approach—where the science of education is just as important as the science of innovation—we risk stifling human advancement and well-being.

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[CAMPUS PRACTICE]

Global Problems as a Framework for Integrated STEM Learning in the First Year

■ **LISA GENTILE,** associate professor of chemistry, and **KATHY HOKE**, associate dean of Arts and Sciences, both of the University of Richmond

The major scientific challenges of the twenty-first century will require interdisciplinary teams to collaborate using tools from a variety of disciplines. Seeking a way to prepare students for this kind of work, a team of faculty members at the University of Richmond (UR) developed a first-year course called Integrated Quantitative Science (IQS). The course incorporates first-semester content in biology, chemistry, physics, mathematics, and computer science in one fully integrated experience that composes half of a student's academic schedule in both semesters of the first year.

IQS, which includes a hypothesis-driven lab, a workshop, and a double lecture, requires a minimum of nine contact hours per week. Ten faculty members—one from each of the five disciplines in each semester—teach the course to twenty students a year. Upon completing the course, these students have explored fundamental concepts in each discipline and are ready for further study in any one of them. They can also continue their interdisciplinary inquiry through various research projects and an integrated science minor, which features courses like Biological Imaging or Math Models in Biology and Medicine. In this article, we describe the IQS's creation and the benefits it derives from being organized around the global scientific challenges that humankind faces today.

Major Societal Questions

At UR, we have found that students' interest increases when topics allow them to engage in major societal questions. We thus organized each semester of IQS around a societally relevant theme. Based on participating faculty members' expertise, we selected antibiotic resistance as the first semester's organizing topic and cell signaling and communication, with its ties to understanding disease, as the second semester's.

One of the course's primary goals is to train students to think like scientists. The course thus emphasizes inquiry-based pedagogy through workshop and laboratory sessions. In the first semester, students conduct a multiweek, multidisciplinary experiment to develop their understanding of antibiotics. They learn mathematical modeling, computational simulation, and experimental approaches to mutation rates. They also conduct a theoretical and computational study of conformational flexibility—that is, the motions of antibiotic molecules. In addition, students perform a series of experiments aimed at discovering new antibiotic-resistant bacteria known to have symbiotic relationships with marine sponges. This requires students to write computer code comparing their experimental results with genetic information found using key bioinformatics tools. In the second semester, students participate in a multiweek laboratory module where they explore how immune cells are activated and how they respond to infection. Image processing (as related to magnetic resonance imaging, or MRI) and HIV protease drug design, as well as resistance and reaction rates, are other major focal points.

Lectures lay the groundwork for this experimental inquiry by introducing key concepts from each discipline within the context of the umbrella theme. For example, in the first semester, an introduction to evolution by natural selection leads to a discussion of antibiotic resistance. The study of antibiotics facilitates learning about bonding, diffraction, spectroscopy, energy minimization algorithms, and Monte Carlo methods, and students learn mathematical modeling in the context of how infection spreads in hospitals. In the second semester, students begin exploring cell signaling by learning how to use integral calculus to analyze how signals accumulate to a threshold. They study random walks and diffusion as mechanisms for transporting signals within particular pathways, kinetics and thermodynamics in the context of HIV protease, and rotational kinematics and image processing in the context of MRI. Through these topics, the course emphasizes quantitative reasoning, algorithmic processes, and mathematical models to a greater extent than is typical in traditional science courses. After all, the big problems confronting humankind will only become tractable with improved designs, techniques, instrumentation, models, and algorithms generated through interdisciplinary thinking.

At UR, we have found that students' interest increases when topics allow them to engage in major societal questions.

Supports and Challenges

Embarking on a project of this magni-

tude requires multiple layers of support. UR secured funding for the project through a science education grant from the Howard Hughes Medical Institute (HHMI), building on past HHMI and Merck–American Association for the Advancement of Science grants that supported upper-level course development and interdisciplinary research projects (Caudill et al. 2010). In addition, the project aligned with UR's strategic plan, the team had strong administrative support, and each of the five departments agreed that students completing IQS would be prepared to advance to the second course in their majors. Perhaps most important was the support of the talented, creative faculty who developed and taught the course. The faculty team was also fortunate to be selected for the Keck/Project Kaleidoscope Facilitating Interdisciplinary Learning project (Keck/Project Kaleidoscope 2010), which connected its members to a network of twenty-eight schools working on aspects of interdisciplinary undergraduate education.

Despite these strengths, the course was not without challenges during its first year. As expected, integrating the material at a high level was challenging, as was coordinating team teaching among five faculty members. In the second year, the team built reassigned time into faculty schedules to allow for further integration, and the adjustment to team teaching will likely be smoother in the second iteration. Overall, faculty teaching the course have responded positively to their experiences.

Students in the first-semester IQS lab load an agarose gel to analyze genes from antibiotic resistant bacteria. (Photo courtesy of the University of Richmond.)

Assessing Outcomes

The faculty team is thrilled with preliminary measures of success. Ninety-five percent of students enrolled in IQS participated in a full-time summer research experience at UR, and 83 percent are now taking an interdisciplinary research training seminar (part of our integrated science minor). Interest in IQS has grown beyond what we can accommodate, and at least four faculty members began new interdisciplinary research projects as a result of their involvement in the course.

To measure students' perceived learning gains, the team used the Research on the Integrated Science Curriculum (RISC) survey, available at http://www.grinnell.edu/academic/psychology/faculty/dl/risc. In their responses, students reported strong learning gains on items from the related Survey on Undergraduate Research (SURE), available at http://www.grinnell.edu/academic/psychology/faculty/dl/surecure. In fact, in almost all areas, IQS students reported benefits well above average for RISC and SURE comparison groups. Particularly strong were skills in interpretation of results, readiness for more demanding research, ability to integrate theory and practice, and understanding of how scientists work on real problems.

More targeted assessments will be possible as more students take IQS and as students advance further in their educations. For now, we at UR are excited to see the preliminary outcomes from this deliberate integration of STEM disciplines in the context of global issues, both in the classroom and in the undergraduate research experience.

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[CAMPUS PRACTICE]

Sustainable Energy Studies at Eastern Connecticut State University

■ **FRED LOXSOM,** endowed chair in Sustainable Energy Studies, and **NORMA VIVAR**, technical assistant and outreach specialist, both of the Department of Environmental Earth Science at Eastern Connecticut State University

Like many institutions, Eastern Connecticut State University is committed to advancing environmental sustainability both in its institutional practices and through its educational goals. As part of this commitment, Eastern's Department of Environmental Earth Science has developed educational programs in sustainable energy. The motivations for doing so are complex, but stem from the realization that fossil fuel consumption has devastating effects on the environment. Local impacts include air and water pollution, while the major global impact is anthropogenic climate change—a particularly potent motivator, as it threatens human health and welfare and poses increasing risks to future generations.

Because per capita energy use in the United States is much higher than the global average, the United States has an obligation to provide leadership in mitigating and adapting to climate change. Eastern's programs aim to assist students not only in addressing this responsibility, but also in developing the knowledge and skills they need to build successful postgraduate careers.

Academic Programs at Eastern

Eastern's programs in Sustainable Energy Studies are the vehicle for implementing the academic component of the institution's vision for campus sustainability. Two introductory courses, Sustainable Energy and Global Climate Change, are popular general education options that offer gateways into the major, minor, and certificate programs. These courses describe the environmental consequences of fossil fuel consumption and explore strategies for adapting to or mitigating climate change and other environmental impacts. They use discussion, essay writing, and analysis to help students think critically about connections between energy consumption, environmental resources, population, wealth, and sustainability. The courses conclude with participation in a sustainability symposium, where students exhibit the results of group projects that address environmental and social issues related to energy consumption. Educational outcomes include the ability to clearly articulate connections between energy consumption and environmental and social impacts, and the ability to develop and analyze science-based strategies to reduce these impacts.

After completing the introductory courses, some students elect to enroll in the Sustainable Energy Science major program, which exists as a track for those pursuing bachelor of science degrees in Environmental Earth Science. Students in the major acquire technical knowledge and skills in energy analysis, and they learn how that knowledge can be applied in geoscience. They take core courses where they develop scientific understanding of energy resources, renewable energy, and alternative energy technologies, as well as awareness about how these technologies can reduce social and environmental impacts. They also learn to acquire data, analyze energy resources, and model energy applications and energy systems. Many students complete a related internship or an independent study project involving technical, economic, and social analysis. Recent projects have included developing educational materials for middle schools, helping to implement an energy conservation program in the community, helping to develop a renewable energy plan for the campus, and creating a map of geothermal resources in southern New England. The major program prepares students for graduate study in energy science or energy policy or for careers in a wide variety of sectors: government agencies, electric utilities, businesses, education, and nonprofits that address related environmental and social issues. The second cohort of students will graduate from the program in spring 2011.

> The programs prepare students for future employment, but also prepare them to serve the diverse communities that constitute the state and region—and even the planet.

The interdisciplinary minor in Sustainable Energy Studies integrates social science and natural science into a program that puts energy-related

Sustainable Energy Studies Programs

More information about Eastern Connecticut State University's major, minor, and certificate programs in Sustainable Energy Studies is available at http://www.easternct.edu/environmentalearthscience/.

environmental issues within their appropriate economic and political science contexts. Students in the minor program complete the introductory courses and the core energy science courses described above and also choose from a set of approved social science courses. Students select the Sustainable Energy Studies minor to pursue their interest in environmental issues and to prepare for a wide spectrum of future careers, ranging from communication to business.

Working with Eastern's School of Continuing Education, Sustainable Energy Studies faculty have also developed a Green Energy Management for Sustainability certificate program delivered through online courses for nontraditional students. This project has been particularly rewarding, as nontraditional students bring valuable life and work experience to the program, enriching student–faculty interactions with their knowledge and perspectives. The certificate program also helps nontraditional students gain valuable knowledge that enables them succeed in their current jobs or begin new careers.

Outreach Activities

Students, staff, and faculty in Sustainable Energy Studies feel that we have an obligation to share our knowledge and skills with the campus and local community. We therefore reach beyond the science building to make connections both on and off campus, providing informal education and programming designed to build a culture of awareness and a shared sense of responsibility with regard to environmental issues.

Sustainable Energy Studies' on-campus activities convene faculty, staff, and students from every department on campus and from every aspect of campus operations. Participants lead recycling efforts, develop and maintain a campus carbon inventory, promote student environmental clubs, and help develop the climate action plan required by the American College and University Presidents Climate Commitment. As part of the Green Campus Committee, faculty, staff and students come together to share ideas and develop practical solutions to meet campus sustainability goals.

Community activities help students interact with the broad economic and ethnic diversity that is characteristic of the town of Willimantic, where Eastern is located. Faculty and students provide technical help and leadership to energy conservation efforts within the local community. These activities not only aid residents, but also allow students to apply their knowledge and gain experience.

Eastern Connecticut State University students build a wind power system for a school in Lucea, Jamaica.

University Initiatives

Eastern recently completed a new strategic plan that includes two key initiatives relevant to Sustainable Energy Studies: Liberal Arts Work and Global Citizenship. The goal of Liberal Arts Work is that every student complete an internship, independent study project, or other preprofessional experiential learning activity geared toward applying a liberal arts education in a professional setting. Global Citizenship is an initiative designed to expose every student to diverse viewpoints and unfamiliar cultures as a compulsory element of his or her liberal arts education. Each student must complete one course that has been approved as part of the Global Citizenship curriculum. Students can also fulfill additional requirements to reach higher levels of achievement within the program.

Faculty in Sustainable Energy Studies are committed to developing a range of experiential learning activities that will fulfill these requirements. Through longstanding relationships between Eastern and educational institutions in Jamaica, we were able to identify a school in Lucea, Jamaica, that was interested in working with us to develop a service-learning project focused on designing and implementing a renewable energy system. Students and faculty designed a small wind power system for the school, and two faculty members and ten students traveled to Jamaica during spring break to implement the project. This project not only served our community partners, but was also an excellent learning experience for students and faculty. We are now seeking to develop a long-term service-learning project in Jamaica or another locale that will enable students to meet both the Liberal Arts Work and Global Citizenship Initiatives goals.

Conclusion

Eastern Connecticut State University's Sustainable Energy Studies programs build on the strengths of our liberal arts context. The programs prepare students for future employment, but also prepare them to serve the diverse communities that constitute the state and region—and even the planet. We are acting on our obligation to people around the globe and to those who have not yet been born, ensuring that Eastern's faculty, students, and staff help develop strategies for responding to climate change.

[PERSPECTIVE]

Henrietta Lacks: Living on across Multiple Disciplines

■ **JESSE NEIKRIE,** first-year student at Connecticut College

Henrietta Lacks. The first time I heard the name, it meant nothing to me. I was in the car, listening to National Public Radio's (NPR's) *All Things Considered*. Journalist Guy Raz was interviewing Rebecca Skloot, the author of a then-new book, *The Immortal Life of Henrietta Lacks* (2010). It was the beginning of summer, and I was taking full advantage of it, enjoying the luxury of having the time to read what I wanted.

The NPR story grabbed me from the start. Before beginning the interview, Guy Raz gave a brief teaser of the plot:

> Henrietta Lacks, a poor African American woman and mother of five, never knew that she revolutionized medicine. Shortly before she died of cancer in 1951, doctors took a tissue sample from her—without her permission. Those cells became the first human cells to gain "immortality"—replicating themselves in laboratories long after Henrietta Lacks died. (2010)

By the end of the interview, I had mentally added *Henrietta Lacks* to my summer reading list. But the book might have stayed there for several summers if not for the First-Year Summer Reading Program at Connecticut College, where I would enroll in the fall.

First-Year Reading

Since 1989, Connecticut College has required incoming first-year students to read a book chosen by a panel of faculty members from multiple departments. The panel selects something that they feel is engaging to a wide audience, conducive to discussion, and relevant to many disciplines. This year's panel (which consisted of Marc Zimmer from the chemistry department; Carol Akai from the human development department; Amanda Watson, a library liaison with specialties in film, English, and French; and Andrea Rossi-Reder, an English professor and dean of freshmen and sophomores) also hoped to bring Rebecca Skloot to campus to give a lecture and answer questions. "Little did we know the book would soon be picked up by Oprah," joked Dean Rossi-Reder, in reference to Skloot's skyrocketing speaker's fees.

Even without Skloot (who never made it to Connecticut College), *Henrietta Lacks* captivated much of the campus. Unlike the stereotypical reading assignment that too often catalyzes students to bond over mutual dislike, this choice appealed to people with diverse interests, including literature, science, history, philosophy, psychology, sociology, anthropology, medicine, and social justice. As Morgane Amat, a French-born first-year physics major and potential art and math double minor, explained, "I liked the biographical components combined with the scientific knowledge." Opinions about the book were as diverse as the first-year class, who used it as a tool to get to know each other. Inside and outside of classes as well as in student- and faculty-run discussions, which took place almost every other week during the first semester, students gathered to discuss the topics and dilemmas the book posed.

Different Disciplinary Angles

In Professor Derek Turner's bioethics class, students debated the difference between legality and ethicality. "The two do not always align," explained Professor Turner. "If the family had sued, they would not have had much of a legal claim; but justice is totally different." In the 1950s, doctors commonly took tissue samples and tested them in an effort to cure a patient's disease. Because their intent was to help the individual being tested, they rarely sought the patient's formal permission to take these samples. In Henrietta Lacks's case, doctors discovered shortly before she died that her cells could multiply exponentially—an extraordinarily rare and medically significant ability—and they never informed her of this fact. Thus the cells that would transform modern medicine were taken without her knowledge or permission. Since then, Henrietta's cells have provided a basis for medical research that has saved countless lives, making some doctors, researchers, and pharmaceutical companies unbelievably wealthy in the process. But Henrietta herself was a poor black woman, and her family remains so deeply in poverty they can't even afford the medicines her cells helped create. While the doctors who took her cells technically did nothing illegal, the fact that there were no consent forms and no related concept of patient rights at the time poses an ethical dilemma about who has rights to her cells.

On the other hand, if Henrietta had been better informed and had not allowed doctors to take the tissue sample, modern

> Before Skloot's book, despite widespread knowledge of HeLa cells, Henrietta Lacks herself was nearly totally forgotten.

medicine would be radically different. In some science classes, professors like Martha Grossel helped illustrate this lesson from the book by showing students HeLa cells (as Henrietta Lacks's cells are called) that had been chemically treated to freeze them in the process of division (mitosis). Students could thus observe the stages of mitosis under a microscope. "It was really cool!" said freshman Anastasia Elliot, a music and education major and biology minor who plans to be a veterinarian. "We compared the size of the HeLa cells to our own cheek cells. The HeLa cells were tiny compared to ours, and with some of them you could see the chromosomes being pulled apart!" By examining and discussing HeLa cells, first-year science students were already learning to think about the origins of the samples they were studying.

Connecticut College

Immortal Legacies

Despite the book's misleading title, when Henrietta Lacks died on October 4, 1951, she truly died. Her cells—or at least the cells produced from her cells, which may have changed and evolved—exist all over the world. But Henrietta does not live on in them, just as we do not live on in the millions of skin cells we lose every day. In fact, before Skloot's book, despite widespread knowledge of HeLa cells, Henrietta Lacks herself was nearly totally forgotten. But Skloot's book immortalized Henrietta, and scientists will now know the origin of the cells they handle regularly. Just as everyone who receives a polio vaccine can thank Jonas Salk for his research, they can thank Henrietta Lacks for providing the cells he used.

It has now been more than six months since I first heard the name Henrietta Lacks. The person behind the name has now taken shape in my mind. Henrietta was a woman, a mother, a wife, and a cancer patient—in short, a human being who is too often remembered, if at all, as nothing more than an acronym. She is the source of the precious HeLa cells that defined modern medicine, an unsung hero who did not volunteer for the job. And now she is also at the heart of the introduction to my first year in college. Through Rebecca Skloot's book, Henrietta Lacks has set a very high standard for what I hope my college experience will be like. So far, I have not been disappointed. My classmates and I will never forget the life, death, and incredibly busy afterlife of Henrietta Lacks and her unique cells.

REFERENCES

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[RESEARCH REPORT]

Assessment Rubrics for Applied STEM Learning

AAC&U's Valid Assessment of Learning in Undergraduate Education (VALUE) project has created a series of rubrics that are broadly applicable to science, technology, engineering, and mathematics (STEM) learning in global contexts. The fifteen rubrics, available for free download at www.aacu.org/value/rubrics, are useful for assessing student learning outcomes related to three organizing categories: intellectual and practical skills, personal and social responsibility, and integrative and applied learning. All are essential for students preparing to address today's global scientific challenges.

An excerpt of the rubric for quantitative literacy appears below. For more information, contact value@aacu.org or visit the website.

—*Kathryn Peltier Campbell*

Note: Due to space limitations, the excerpt below excludes the intermediate levels of learning (2 and 3). Readers are encouraged to download the entire rubric at www.aacu.org/value/rubrics.

Quantitative Literacy Rubric: An Exerpt

	4	1
Interpretation *Ability to explain information presented in mathematical forms (e.g., equations, graphs, diagrams, tables, words)*	Provides accurate explanations of information presented in mathematical forms. Makes appropriate inferences based on that information. *For example, accurately explains the trend data shown in a graph and makes reasonable predictions regarding what the data suggest about future events.*	Attempts to explain information presented in mathematical forms, but draws incorrect conclusions about what the information means. *For example, attempts to explain the trend data shown in a graph, but will frequently misinterpret the nature of that trend, perhaps by confusing positive and negative trends.*
Representation *Ability to convert relevant information into various mathematical forms (e.g., equations, graphs, diagrams, tables, words)*	Skillfully converts relevant information into an insightful mathematical portrayal in a way that contributes to a further or deeper understanding.	Completes conversion of information but resulting mathematical portrayal is inappropriate or inaccurate.
Calculation	Calculations attempted are essentially all successful and sufficiently comprehensive to solve the problem. Calculations are also presented elegantly (clearly, concisely, etc.)	Calculations are attempted but are both unsuccessful and are not comprehensive.
Application/Analysis *Ability to make judgments and draw appropriate conclusions based on the quantitative analysis of data, while recognizing the limits of this analysis*	Uses the quantitative analysis of data as the basis for deep and thoughtful judgments, drawing insightful, carefully qualified conclusions from this work.	Uses the quantitative analysis of data as the basis for tentative, basic judgments, although is hesitant or uncertain about drawing conclusions from this work.
Assumptions *Ability to make and evaluate important assumptions in estimation, modeling, and data analysis*	Explicitly describes assumptions and provides compelling rationale for why each assumption is appropriate. Shows awareness that confidence in final conclusions is limited by the accuracy of the assumptions.	Attempts to describe assumptions.
Communication *Expressing quantitative evidence in support of the argument or purpose of the work (in terms of what evidence is used and how it is formatted, presented, and contextualized)*	Uses quantitative information in connection with the argument or purpose of the work, presents it in an effective format, and explicates it with consistently high quality.	Presents an argument for which quantitative evidence is pertinent, but does not provide adequate explicit numerical support. (May use quasi-quantitative words such as "many," "few," "increasing," "small," and the like in place of actual quantities.)

In Print

***Sustainability Education: Perspectives and Practice Across Higher Education*, edited by Paula Jones, David Selby, and Stephen Sterling (Earthscan 2010, $49.95 paperback)**

This comprehensive and scholarly volume opens a window to sustainability practices in higher education institutions across the United Kingdom. With chapters that explore the potential for sustainability to be included in the curricula of various disciplines, the authors compellingly suggest that a series of paradigm shifts will be necessary for attempts to integrate sustainability across the curriculum to succeed. Although not all models discussed are transferable to a US institutional context, the book provides valuable global perspectives on a topic that connects educators across national boundaries.

***Recognizing and Serving Low-Income Students in Higher Education: An Examination of Institutional Policies, Practices, and Culture*, edited by Adrianna Kezar (Routledge 2011, $45.95 paperback)**

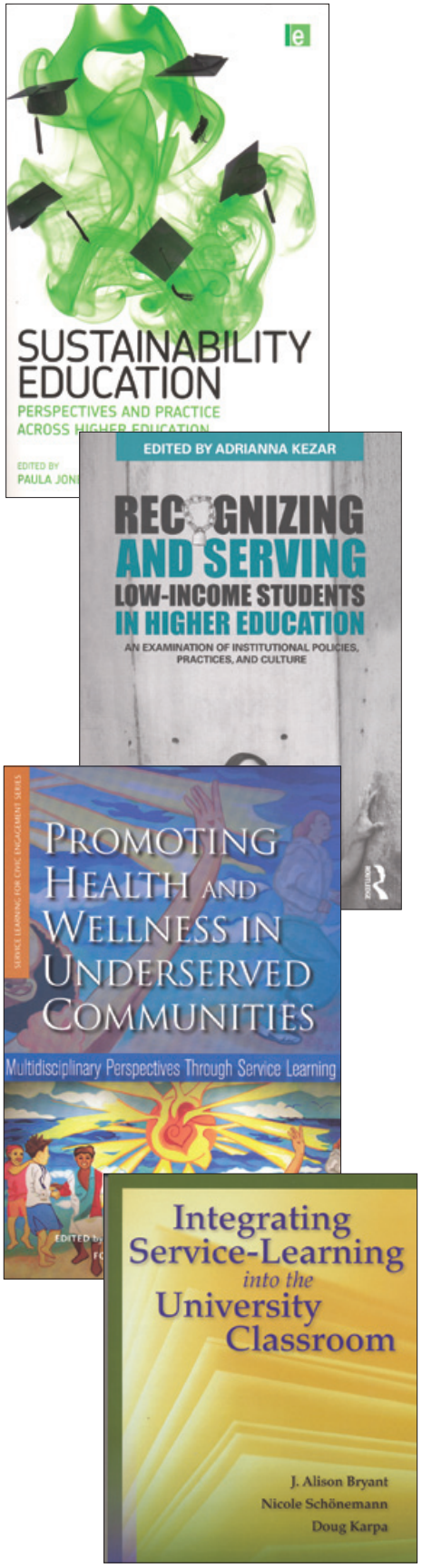
Contributing authors share a post-structuralist approach to rethinking programs and policies aimed at helping low-income students succeed in higher education in this new volume edited by Adrianna Kezar. Each chapter applies theory in an effort to critique current practices and suggests promising alternatives to help low-income students find individual efficacy within a system that often works against them. The book gives a broad view of the kinds of supports low-income students can encounter upon applying to, enrolling in, attending, and graduating from college. The volume is an excellent addition to the library of anyone seeking a thoughtful analysis of this underappreciated topic.

***Promoting Health and Wellness in Underserved Communities: Multidisciplinary Perspectives through Service Learning*, edited by Anabel Pelham and Elizabeth Sills (Stylus 2009, $27.50 paperback)**

In taking up the pressing topic of community health and wellness, editors Pelham and Sills emphasize how service learning can be one channel for colleges and universities not only to provide needed support to community partners, but also to promote engaged and experiential learning for their students. With examples from disciplines based in the health sciences as well as those at further removes, such as anthropology and English language learning, the book suggests multiple projects that institutions can implement to the benefit of both students and communities. Part of a series on "service learning for civic engagement," the volume views this topic through the lens of public health and is a strong resource for faculty in related fields.

***Integrating Service-Learning into the University Classroom*, J. Alison Bryant, Nicole Schönemann, and Doug Karpa (Jones and Bartlett 2011, $32.95 paperback)**

This collection of course "portfolios" highlights several ways that college instructors can incorporate service learning into their teaching, whatever their courses' subject matter or overarching aims. The volume divides service-learning courses into three types—those oriented to service, those rooted in disciplinary teaching, and those focused on client needs—and provides detailed descriptions of course content and analysis of outcomes for several pedagogical models within each category. The book is an inspiring resource for anyone considering ways to incorporate service-learning pedagogy into individual courses, whatever their disciplinary approach.



Resources

Purposeful Work: Students Talk about Local and Global Responsibilities

At AAC&U's Diversity, Learning, and Inclusive Excellence meeting in October 2010, Dean Richard Vaz and students David Arnold and Evan Sawyer of Worcester Polytechnic Institute reflected on how local and international engineering projects help students integrate and apply their learning. A podcast of the presentation, as well as of other conference plenaries, is available at http://www.aacu.org/Podcast/podcasts.cfm?id=150.

Engineers without Borders

Engineers without Borders facilitates long-term campus–community connections through student chapters at colleges and universities nationwide. Participating chapters work with community partners to develop projects that are community-driven and last for at least five years. To learn more, visit http://www.ewb-usa.org.

Global Brigades

Global Brigades is a student-led organization that conducts service projects for global health and sustainable development. Projects focus on nine topical areas, including architecture, law, microfinance, and public health. Students interested in creating or joining a brigade should visit http://globalbrigades.org.

Project Kaleidoscope

AAC&U is now partnering with Project Kaleidoscope (PKAL) to advance "what works" in undergraduate science education. Past and upcoming PKAL events include a March 2011 meeting on Engaged STEM Learning and Summer Leadership Institutes for STEM Faculty. To learn about additional PKAL events, publications, and resources, visit http://www.aacu.org/pkal.

Opportunities

NCORE 2011 Conference

The 2011 National Conference on Race and Ethnicity in Higher Education (NCORE) will occur on May 31–June 4 in San Francisco, California. Keynote speakers will include undersecretary of education Martha J. Kanter and higher education scholar and equity advocate Estela Mara Bensimon. To register for the conference, visit http://www.ncore.ou.edu.

AASHE 2011 Conference

The Association for the Advancement of Sustainability in Higher Education will host its fourth annual conference on October 9–12, 2011, in Pittsburgh, Pennsylvania. This year's conference theme is "Creating Sustainable Campuses and Communities." For event details, visit http://conf2011.aashe.org.

Educating for Personal and Social Responsibility

AAC&U will host its second Network for Academic Renewal meeting on the topic of Educating for Personal and Social Responsibility on October 13–15, 2011, in Long Beach, California. The conference will focus on such topics as refining and assessing outcomes, innovative models and pedagogies, research findings, and institutional leadership. To learn more, visit http://www.aacu.org/meetings/psr11/index.cfm.

Save the Date: AAC&U Annual Meeting 2012

AAC&U will host its next Annual Meeting in Washington, DC, on January 25–28, 2012. Watch for the call for proposals, to be posted in May with a July deadline. For more information, visit http://www.aacu.org/meetings.

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Upcoming AAC&U Meetings

MEETING	LOCATION	DATES
Educating for Personal and Social Responsibility: A Twenty-First-Century Imperative	*Long Beach, California*	**OCTOBER 13–15, 2011**
Arts and Humanities: Toward a Flourishing State?	*Providence, Rhode Island*	**NOVEMBER 3–5, 2011**
AAC&U Annual Meeting 2012	*Washington, DC*	**JANUARY 25–28, 2012**

AAC&U Associates

Enrollment in the Associates program provides an opportunity for individuals on AAC&U member campuses to advance core purposes and best practices in undergraduate education and to strengthen their collaboration with AAC&U's Office of Diversity, Equity, and Global Initiatives. Associates pay $60 per calendar year and receive the same benefits as AAC&U Campus Representatives, including subscriptions to our print publications, *Liberal Education, Peer Review,* and *Diversity & Democracy,* electronic copies of *On Campus with Women,* invitations to apply for grant-funded projects, and advance notice of calls for proposals for institutes and meetings. For more information, please visit www.aacu.org or call Renee Gamache at 202-884-0809.

About AAC&U

AAC&U is the leading national association concerned with the quality, vitality, and public standing of undergraduate liberal education. Its members are committed to extending the advantages of a liberal education to all students, regardless of academic specialization or intended career. Founded in 1915, AAC&U now comprises more than 1,200 member institutions—including accredited public and private colleges and universities of every type and size. AAC&U functions as a catalyst and facilitator, forging links among presidents, administrators, and faculty members who are engaged in institutional and curricular planning. Information about AAC&U membership, programs, and publications can be found at www.aacu.org.

From AAC&U Board Statement on Liberal Learning

AAC&U believes that by its nature… liberal learning is global and pluralistic. It embraces the diversity of ideas and experiences that characterize the social, natural, and intellectual world. To acknowledge such diversity in all its forms is both an intellectual commitment and a social responsibility, for nothing less will equip us to understand our world and to pursue fruitful lives.