



SCIENCE EDUCATION FOR NEW CIVIC ENGAGEMENTS & RESPONSIBILITIES



SENCER IDEALS

- ✦ **SENCER** robustly connects science and civic engagement by teaching *through* complex, contested, current, and unresolved public issues to basic science.
- ✦ **SENCER** invites students to put scientific knowledge and the scientific method to use on matters of immediate interest to students.
- ✦ **SENCER** helps reveal the limits of science by identifying the elements of public issues where science does not help us decide what to do.
- ✦ **SENCER** shows the power of science by identifying the dimensions of a public issue that can be better understood with mathematical and scientific ways of knowing.
- ✦ **SENCER** conceives the intellectual project as practical and engaged from the start, as opposed to other science education models that view the mind as a kind of “storage shed” where abstract knowledge may be secreted for vague potential uses.
- ✦ **SENCER** seeks to extract from the immediate issues, the larger, common lessons about scientific processes and methods.
- ✦ **SENCER** locates the responsibility (the burdens and the pleasures) of discovery as the work of the student.
- ✦ **SENCER**, by focusing on contested issues, encourages student engagement with “multidisciplinary trouble” and with civic questions that require attention now. By doing so, **SENCER** hopes to help students overcome both their unfounded fears and their unquestioning awe of science.



ONE OF THE THREE PHYSICISTS CURRENTLY SERVING IN CONGRESS points out that the gap between science and non-science—the “two cultures” divide identified by C.P. Snow 50 years ago—has widened into a great chasm. How unnecessary and unfortunate this is.

Today, more than at any time in our nation’s history, opportunities abound for study in the STEM (science, technology, engineering, and mathematics) fields. Not only are more programs and courses available, but more Americans are attending college than ever before. Supply seems to be well ahead of demand.

The issues in Snow’s day were surely vexing, but our nation’s democracy and today’s “flatter” world economy are now faced with even more complex challenges. Ironically, many of these contemporary challenges are themselves by-products of new scientific discoveries, sophistication in mathematical and statistical modeling, and advances in technology and engineering. Needs have surely grown substantially.

We know that rising above these new challenges will require the contributions of graduates with more sophisticated knowledge in science and math as well as the broad range of skills and dispositions that can be developed through scientific inquiry. These skills include the ability to think critically, collaborate productively, observe closely, and communicate effectively, and dispositions to imagine, invent, create, and solve problems.

Something needs to be done to match our needs and our resources more effectively. Confronting these conditions, leaders at all levels of education are asking these questions:

- Why do so few students study science and mathematics? What can we do about it?
- How can we make science and mathematics real and relevant to students’ lives?
- How can we promote high standards *and* reduce the high casualty rates in STEM courses?
- What must we do to make “scientific and quantitative literacy” into more than just words?

Since the challenges we face are not only questions about educational policies and practices, but reflect on the future of our democracy, other questions arise:

- Can we understand and act effectively upon the many complex issues we face without a working knowledge of science and some quantitative ability? How can we acquire this knowledge?
- What kinds of mistakes will we make if we underestimate either the power or the limitations of science? What can we do to avoid these mistakes?
- What basic values are shared and can be reinforced by those engaged in democratic practice and scientific practice? Where do these practices diverge?
- How can educational institutions encourage democratic values and strengthen students’ capacities for civic engagement and responsible citizenship?

If these questions resonate with you, I would like to invite your interest and participation in SENCER (Science Education for New Civic Engagements and Responsibilities), the signature program of NCSCCE (National Center for Science and Civic Engagement).

Working with support from the National Science Foundation and in collaboration with hundreds of educators, academic leaders, students, and experts in assessment and cognitive theory, we believe we have evolved an approach, developed a set of strategies and resources, and established a community of practice for improving learning in science, mathematics, and across the curriculum. We believe the SENCER approach can strengthen our democracy by improving our students’ capacities for engagement with the greatest issues of our day.

This publication provides an overview of SENCER and the resources available to you. We welcome your interest and look forward to learning how you would like to engage with our work.

Wm. David Burns

Co-Founder and Principal Investigator, SENCER
Executive Director, National Center for Science and Civic Engagement

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This viewbook debuts the new SENCER logo, which employs a tagline, “applying the science of learning to the learning of science” that we believe conveys something of our mission and a new graphic of intersecting half-circles or waves that we hope conveys an idea of communication, interaction, and collaboration.

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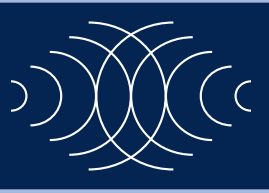


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The inside back cover pocket contains lists of participants, key personnel, and suggestions on ways to engage with SENCER.





strengthening **LEARNING**

SENCER improves science education by focusing on real-world problems and, by so doing, extends the impact of this learning across the curriculum to the broader community and society. We do this by developing faculty expertise in teaching *to* basic, canonical science and mathematics *through* complex, capacious, often unsolved problems of civic consequence. Using materials, assessment instruments, and research developed in the SENCER project, participating faculty, academic leaders, and students create courses and larger-scale curricular projects that connect science and mathematics learning to real-world challenges.



INTRODUCTION

SENCER aims to get more students interested and engaged in learning; to help students connect learning to their other studies; and to strengthen students' understanding of science and their capacity for responsible work and citizenship. Our courses and programs are designed to improve intellectual capacity.

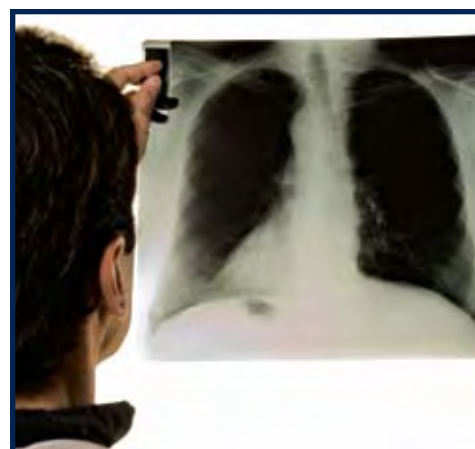
Our thesis is that improved intellectual capacity originates and develops within a student's interests and motives. When learning is illuminated by real issues of civic importance, then that learning can also enhance a student's civic capacity. Our goal is to help students and graduates to *make* our democracy, not just equip them to survive in it.

SENCER was established with the fundamental goal of helping students gain abilities in science, technology, engineering, and mathematics (STEM). By taking into consideration that learning is the construction of knowledge by the individual—construction that is mediated

by the context of the learning, by the social environment, and by the prior knowledge of the learner—SENCER builds on longstanding traditions: from those now denominated as Aristotelian through the Enlightenment's uniting of the liberal arts and the natural sciences. SENCER's more modern intellectual lineage can be found in the extension education ideals emanating from the Land Grant movement and the pragmatism of William James.

■ ■ ■

This publication provides a comprehensive “view” of the SENCER program as we approach our 10th anniversary. It is divided into four sections that reflect SENCER's broad program goals: strengthening learning, empowering community, expanding knowledge, and supporting innovation. These general sections serve to highlight program elements, describe project activities, and invite opportunities for your involvement.





In this section, we provide a brief overview of the project and describe the SENCER models, exemplars of the on-campus work that inspires innovation in STEM education and succeeds in promoting desired learning gains.

ABOUT SENCER

Founded in 2001 by David Burns and Karen Oates, Science Education for New Civic Engagements and Responsibilities (SENCER) is a National Science Foundation-supported faculty-development and science-education reform initiative.

SENCER is the signature program of the National Center for Science and Civic Engagement (NCSCE). NCSCE is affiliated with the Harrisburg University of Science and Technology, a new, private, not-for-profit, accredited institution that offers innovative programs in mathematics, science, and technology designed to meet the needs of the citizens of Central Pennsylvania and the nation. The National Center develops projects and supports activi-

ties that strengthen the efforts of colleges and universities to enhance student learning at all educational levels and settings and to engage students and campus communities with pressing civic and social questions.

In addition to the contributions of our many volunteer collaborators, scholars, and senior fellows, both NCSCE and SENCER benefit from the support of a distinguished national advisory board, whose members are listed in an insert in the back pocket of this viewbook.

Since its inception, SENCER has encouraged a growing community of educators, students, and academic leaders from schools, community colleges, baccalaureate and graduate-degree-granting colleges and universities, as well as governmental and nongovernmental organizations—all working to improve STEM education.



The positive results reported by those teaching and learning in SENCER courses have been confirmed



I believe deeply that our global society needs SENCER.

We must ensure that our future leaders—scientists and non-scientists alike—appreciate the complexities of society's problems and work together to seek solutions to them.

—Ellen Goldey, Professor of Biology, Wofford College



by independent evaluators. Their research has established that the SENCER approach is especially effective in improving science literacy and increasing student confidence and skills at a level of statistical significance in women students and students who have traditionally underperformed in STEM courses and programs. This is especially significant because students who tend to avoid study in the STEM fields, the so-called non-majors, were the original targets of the SENCER program. In the words of a colleague from the National Research Council, the “introductory courses in science or mathematics are in reality the students’ terminal courses” in these areas.

The challenge regarding women students is different: underperformance is not the key issue. Elaine Seymour (1997) and others have found that high-performing female students in STEM courses and majors leave these courses for other reasons. The experience of our project suggests that these trends can be reversed when students are engaged with learning that is both intellectually chal-

lenging and directly connected to real matters of genuine importance. The findings have led many affiliated with SENCER to expand their SENCER courses to students majoring in the STEM fields.

We think our approach has been successful because SENCER-influenced courses and programs—in addition to emphasizing real-world contexts and problems—explicitly embrace pedagogical strategies that reflect the recent scholarship of cognitive scientists on how we actually learn. These strategies emphasize learning that is active, authentic, inquiry-based, and connected to research. Many SENCER courses also include academically based service-learning projects and strategies such as collaborative learning and community-based research. These courses connect learning to civic issues and promote teamwork and interdisciplinary connections.

One of the nation’s leading experts on learning, John Bransford, co-chaired the committee that wrote *How People Learn* (1999), the landmark report of the National





Academies of Science (NAS) that presents new research about the mind and brain and its implications for what we teach, how we teach it, and how we assess students. A member of the NAS Board on Science Education and the Mifflin Professor of Education at the University of Washington, Bransford observes that SENCER is “bringing to life the recommendations we made” in *How People Learn*.



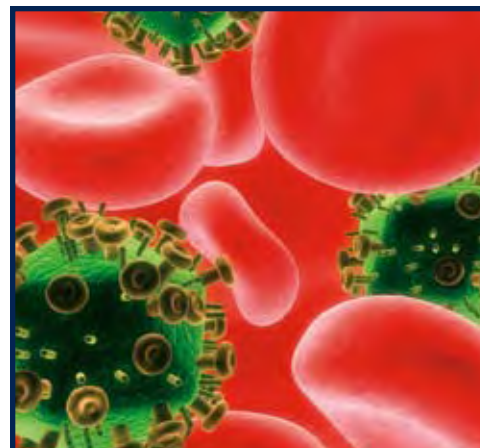
SENCER is many things. On one level, it is an idea, as expressed in the SENCER ideals found on the inside cover of this viewbook. On another level, SENCER is a faculty development and dissemination project that offers national and regional symposia and workshops throughout the year to support campus-based work, a website with myriad resources, including assessment tools, and a national office that organizes programs and issues biweekly e-news updates. On still another level,

SENCER is a community of practice—a group of scholar-practitioners working toward similar ends, sharing findings, and planning the next steps in an unfolding reform program. At the same time, SENCER is documenting achievements and promoting recognition for the good work that its affiliates are accomplishing.

Indeed, members of the SENCER community have been recognized for their work with tenure, promotions, teacher-of-the-year awards, and funding from foundations and government agencies to support further project development. In December 2008, the American Society for Cell Biology honored SENCER and its founders with the Bruce Alberts Award for Excellence in Science Education “in recognition of the tremendous impact of their innovative program.”

Perhaps the best way to discover what SENCER is, however, can be found in the “SENCER models”—the field-tested courses, programs, and learning communities that have been selected for their power to





demonstrate the possibilities and the effectiveness of the SENCER approach.

MODEL SERIES

During the first years of the project, we selected about three dozen examples of courses, programs, and learning communities as “models” because they exemplified the SENCER approach of teaching *through* a topic of civic consequence *to* the basic STEM content. Some of these courses were developed by scholars who had never heard of SENCER. These scholars could see how their work embodied our goals. They were happy to share their work with others seeking to improve STEM education.

As the SENCER program has developed, more and more courses chosen as models have been the direct products of participation in our project. We are, in the words of one of our South African collaborators, “growing our own timber.” With the number of SENCER-supported development projects growing in maturity and with the development of the SENCER digital library (described on page 26), we anticipate that faculty members will have an opportunity to submit their work for consideration for model status and that our collection of models will grow significantly over the next few years.

SENCER models are diverse in their topics and applications. The course topics cover complex, capacious civic issues such as food security, obesity, diabetes, water quality, emerging diseases, nanotechnology, computer ethics and privacy, nuclear energy, and the many dimensions of something as common as sleep deprivation. Those interested in improving quantitative literacy will be interested in the growing collection of models that use civic issues

to teach basic and advanced mathematics, including differential equations. The SENCER models range from stand-alone courses and course intersections, to linked courses and learning communities, to multi-college collaborations. The models were developed and beta-tested by scholars from all sectors of higher education.

Though the published models contain many valuable resources—syllabi, reading lists, simulations, laboratory and fieldwork exercises, assignments, assessments, tests, supplementary materials, and illustrations—their purpose is not to provide ready-made texts that others can simply adopt for their classrooms as some instructors might adopt a textbook or a lab guide. Rather, our purpose in featuring these remarkable models is heuristic: to show the possibilities, the ways to construct courses that embody the SENCER ideals.

Throughout this publication, we provide four examples of the real-world application of the SENCER ideals in the field-tested SENCER course models:

- “Science on the Connecticut Coast: Investigations of an Urbanized Shoreline” on page 11.
- “Life Science in Context: Sub-Saharan Africa and HIV/AIDS” on page 19;
- “Quantitative Literacy through Community-Based Group Projects” on page 27; and
- “Pregnancy Outcomes in American Women” on page 35;

Full text versions of all current SENCER models may be found at www.sencer.net. SENCER continuously adds to the collection of programs and courses in our model series.

Engaging Students as Scientists and Citizens

"I believe in doing science that has direct social relevance to [our local] area. By doing this, students demonstrate more enthusiasm for learning while investigating issues that are relevant to their lives." — Vincent Breslin



How prepared is Connecticut for a major hurricane? How has past sediment contamination affected the quality of New Haven Harbor? What are the consequences of climate change on state residents?

Southern Connecticut State's "Science on the Connecticut Coast: Investigations of an Urbanized Shoreline" seeks to answer these questions, and others, by combining four modules into one innovative course for non-science majors.

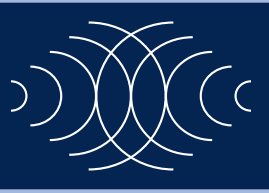
The modules—geology, coastal processes, coastal pollution, and climate change—work together to teach students environmental science through issues associated with living on a densely populated, low-lying shoreline with a history of industrial development dating back to the 1700s.

A priority of the course, according to Vincent Breslin and James Tait, both of SCSU's Department of Science Education and Environmental Studies, is the engagement of students as both scientists and citizens. "Scientific literacy involves understanding science as a process," they say. "This allows citizens to consider scientific results and recommendations critically. We accomplish this by teaching science in the context of local environmental problems. The data then becomes part of a publicly available data set that can be used by environmental protection agencies, scientists, or policy makers.

"I believe in doing science that has direct social relevance to [our local] area," says Breslin. "Doing this, students demonstrate enthusiasm for learning while investigating issues relevant to their lives."

By combining field-based research and guided inquiry, the class succeeds in strengthening students' understanding of science and their capacity for responsible work and citizenship.





empowering **COMMUNITY**

SENCER has been organized to promote collaboration and community and to take full advantage of the manifold contributions that the community's members can make to the success of an enterprise. The SENCER ethos, according to one observer, is "to use community to build collective and critical knowledge, not to foreground the limitations that we each bring to the hard work both of learning science and improving education." The SENCER organizers have always acted on the belief that community is created and sustained by focusing on common purposes, understanding what motivates people, and meeting the needs of community members.



It is one thing to find a kindred spirit. It is another to find someone who is willing to work with you on a project. This is as true for curriculum development as it is for democratic practice.

For those concerned with improving STEM education, SENCER is a powerful resource. Our community counts as its members more than 1,500 educators, academic leaders, and students from more than 350 colleges and universities, as well as a growing number of schools, associations, government-affiliated organizations, and nongovernmental organizations, drawn primarily from the United States, but also from several foreign nations.

SENCER is organized to help its members make personal, productive, and durable connections with each other. This begins in the face-to-face contacts established in regional meetings sponsored by the SENCER Centers for Innovation and the SENCER Summer Institutes. Community is empowered and sustained by our SENCER leadership fellows and visiting scholars and is

supported virtually through our working groups, our biweekly e-news and our web presence, all described in this section.

SUMMER INSTITUTES

Creating effective courses and curricula is challenging. Even in the best of circumstances, development can be complicated by the “natural distractions” of campus life: heavy courseloads, the plethora of other campus obligations, and such apparently simple things as finding the time for colleagues to regularly meet during the academic year.

The SENCER Summer Institutes—the centerpieces of our staff-development efforts—are designed to be times for reflection and accomplishment by faculty, academic leaders, and students working to achieve goals for improved learning through course design or redesign.

The annual Institutes facilitate project development by providing uninterrupted work time for teams,





a connection to peers from around the country, and opportunities for immediate consultations with experts in course design.

Initiated in 2001, the Summer Institutes are invitational, intensive residential experiences for educators and administrators who desire to reorganize courses and curricula around relevant civic issues to improve student learning, specifically in STEM disciplines. The Institutes draw a multidisciplinary group of participants from all higher education sectors, schools, government organizations, non-government organizations, as well as educational and professional associations. Institutes are hosted on campus by colleges and universities that have a special involvement with SENCER. In the first years of the project, the Institute was held at Santa Clara University. In recent years, given high travel costs and in order to take advantage of the special assets that our diverse campus hosts offer our participants, we have moved the Institute location each year to different regions of the

nation. With the growth of our Centers for Innovation, we are organizing the Summer Institutes in collaboration with these regional partners.

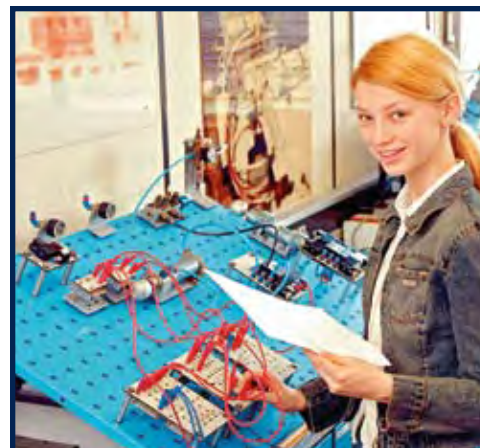
Summer Institute attendees learn about new pedagogies and assessment techniques, share results of implementations, discuss ongoing research in the science of learning, and join a vibrant community of practice. First-time participants are introduced to a network of returning alumni who mentor new teams and offer informal consultations after the Summer Institute. The Institute program offers a mix of plenary sessions, concurrent presentations, poster sessions, half-day workshops, networking opportunities, and designated work time to facilitate campus reforms.

The Institutes are particularly structured to foster the work of campus teams of administrators, educators, and students who attend in order to create or refine course-based or campus-wide projects in the company of innovative practitioners. Teams are often composed



SENCER's 2007 Summer Institute was truly a transformative experience for our TWU team. It was the catalyst for new thinking and intellectual excitement that has led to the development of SENCER courses in STEM disciplines. We're now connected with a community of terrific colleagues. We've supported an ssi team each year since and will continue to do so.

**— Ann Q. Staton, Dean of the College of Arts and Sciences,
Texas Woman's University**



of individuals representing different disciplines, departments, and roles on campus.

Team members who have participated in a Summer Institute have described the time together away from campus as “invaluable” and “essential” in establishing a solid plan for course or curricular reform for the following academic year.

SENCER also welcomes attendance by individual newcomers who are considering the applicability of the approach to projects on their own campus and who would bring a team to future Institutes. Individual alumni of past meetings and Institutes are invited to present sessions or posters on their own research and campus-based reforms. This mix of alumni and newcomers has greatly enriched the experiences of both cohorts and is a critical ingredient in community building.

In the months following the Summer Institute, SENCER supports participants and members of the community at large through local and regional meetings and workshops, frequent electronic communication, publications, and on-site consultations when needed.

Participants in the SENCER Summer Institutes pay fees that cover their lodging, food, and some incidental expenses. Participants are also responsible for their own travel costs. SENCER, with support from the NSF, provides the “tuition” and other program elements and makes available sub-awards for teams on a competitive basis to support implementation of promising SENCER projects (see page 30).

CENTERS FOR INNOVATION

Established in 2008, SENCER Centers for Innovation (SCI) organize and provide regional networks to support

the growing alumni community and to serve as points of entry and engagement for newcomers to SENCER’s work. There are currently five centers and host institutions:

- New England (Southern Connecticut University),
- Mid-Atlantic (Rutgers University),
- South (University of North Carolina at Asheville),
- Midwest (Harold Washington College of the City Colleges of Chicago), and
- West (Santa Clara University).

Each center is supported jointly through contributions from SENCER and its host institution. The SCIs offer workshops and symposia to complement national programs, provide local experts for on-site consultations, support and extend the work of local Leadership Fellows, and offer guidance on course development, assessment and implementation. Typically, each SCI plans and/or collaborates with other organizations in sponsoring two workshops per year.

While SCI-sponsored programs are open to participants from around the country, they are specifically designed to address the needs and interests of their respective regional communities. To that end, our centers are exploring collaborations focused on regional challenges, such as water quality. With help from the national office, they are also beginning to seek funding to support jointly developed courses, curricula, and related research initiatives.

Each SCI is led by co-directors and guided by members of leadership councils who represent educational and other institutions in the region. All five centers maintain web presences that can be accessed from the main SENCER website. Contact information for all SCI



co-directors is presented in an insert in the back pocket of this viewbook.

LEADERSHIP FELLOWS PROGRAM

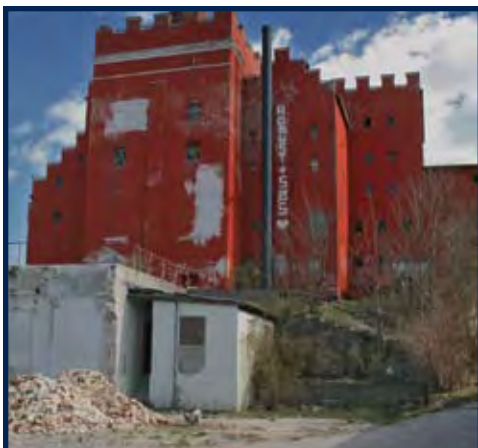
The Leadership Fellows Program offers SENCER alumni the opportunity for greater involvement in the SENCER initiative and affords the National Center Science and Civic Engagement occasions to formally recognize the hard work and significant accomplishments of those who have developed strong programs.

Fellows help guide the SENCER project by participating in annual meetings of the Leadership Fellows Council. They develop and carry out projects that extend the reach and deepen the impact of the SENCER program on their campuses, in their disciplines, and in their communities. They report their progress using an interactive database. As noted, fellows participate in regional initiatives through their affiliation with the Center for Innovation of their choice.

Fellows serve 18-month terms and identify specific activities that will become the foci of their term. Each fellow commits to:

- Promoting the wider campus adoption of SENCER principles in undergraduate STEM courses through presentations, seminars, and informal discussions;
- Guiding the development of at least one additional SENCER project/course on campus;
- Engaging and mentoring other faculty members (and students who intend to be teachers) in implementing SENCER approaches; and
- Connecting with and supporting regional activities, where feasible and appropriate.

Applications and nominations for election to the Leadership Fellows Program are welcome at any time. Decisions on the applications are made semi-annually by National Fellowship Board, a group of distinguished educational leaders and scholars. Interest in the program





is especially solicited from applicants proposing fellowship projects that:

- Develop strategies to encourage students to take SENCER courses early in their academic careers (especially pre-service teacher education candidates);
- Coordinate institutional participation in the SENCER-SALG (see page 24) and other assessment activities;
- Create and test curricular materials in new applications and topics;
- Organize and carry out consultations and workshops at nearby colleges or at local, state, and national disciplinary organizations.

VISITING SCHOLARS

The SENCER national office invites faculty and academic leaders who want to pursue research interests connected to SENCER's goals and are willing to devote a sabbatical period to supporting our national dissemination efforts to apply for appointment as a Visiting Scholar.

Scholars generally serve for a semester or a year and are designated by their major professional identification, such as "SENCER Visiting Scientist," or "SENCER Visiting Mathematician."

To be considered, applicants submit brief proposals, discuss their proposed activities with project staff, and supply evidence of institutional support. We provide reciprocal letters of support and agreement for the scholar's institution. Visiting scholars do not have to be in residence but may use the national offices when in Washington, D.C. While SENCER offers no salary subvention, we do provide modest support for travel, presentations at relevant meetings, and other activities.

WEBSITE AND E-NEWS

SENCER maintains a vibrant website at www.sencer.net that provides all visitors access to the full text of the model series and backgrounders, a variety of assessment tools, information and applications for national and regional symposia, best practices/campus reports, job opportunities, grant announcements, and press releases.

We invite all who are interested in SENCER to use our website to sign up to receive our biweekly e-news. The newsletter will enable you to stay current on project developments, to learn about new opportunities and strategies to improve STEM education, and to maintain connections with the SENCER community.



Life Science in Context

"When you study science globally, it makes you more aware of your country, your state, your science."

— John Mecham



Engaging students as both scientists and citizens is the goal of the successful inter-institutional collaboration "Sub-Saharan Africa and HIV/AIDS."

The course capitalizes on regional networks and expertise to integrate HIV/AIDS into courses at three different institutions.

At Meredith College, "Sub-Saharan Africa and HIV/AIDS" is an honors colloquium focusing on HIV/AIDS and nutrition. At North Carolina Wesleyan, "East African Wildlife and Human Interactions" is a biology course that explores interactions between wildlife and humans considering various ecological dimensions of a problem. At the University of South Carolina, Sumter, the biology course "Human Anatomy and Physiology" is a lecture and laboratory course taken by all biology majors and covers the biology, statistics, testing, and transmission of HIV/AIDS.

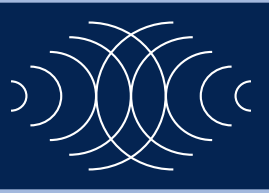
In addition, this collaborative effort— spearheaded by John Mecham, Erica Kosal, and Pearl Fernandes— provides faculty development workshops for the consortium participants. These workshops provide an overview of current research, in-class activities, hands-on laboratory experiments, and other teaching resources.

To ensure that the science of HIV/AIDS is learned in the larger civic and social context of the sub-Sahara, consortium members also work with local and international experts, including faculty from Duke University and Kenya's Kenyatta and Egerton Universities.

"When you study science globally, it makes you more aware of your country, your state, your science," says Mecham.

ASSESSMENT





expanding **KNOWLEDGE**

For learning to be worthwhile, it must have a transitive quality. It must take us to new places and add depth to our understandings of the familiar. SENCER's approach to teaching science makes it real and relevant and gives all concerned a stake in expanding knowledge and sharing the products and outcomes of their learning. SENCER enables students and faculty to use their intellectual gifts to focus on unsolved problems and to expand knowledge and discover new strategies to produce better outcomes, in learning and in life.



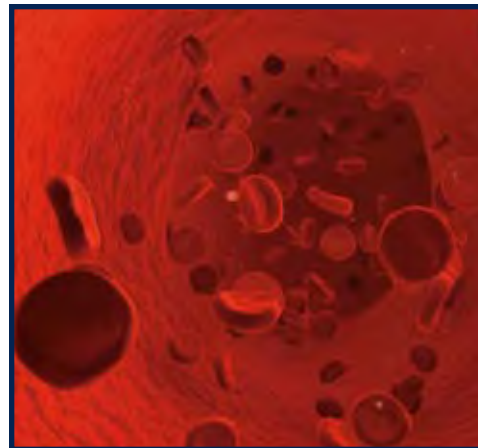
How do we know that our goals are being achieved? How do we acquire insights about our practice that we can use to improve what we are doing?

Developing tools and strategies to continually evaluate and assess learning effectiveness has been a hallmark of SENCER since its inception. Indeed, one message we heard frequently while developing the project was that our potential collaborators wanted national, common (but customizable), and validated assessment tools and strategies that they could use to justify and improve their campus-based programs. This led us to ask the National Science Foundation to provide SENCER with supplementary funds to support the expansion and customization of an online assessment resource, the SENCER-SALG, to enable students to assess their own learning gains. SENCER-SALG results complement the evaluations that faculty traditionally make and provide formative assessment information that can be used to improve teaching and learning.

We have already mentioned the statistically significant gains in learning that our researchers reported after analyzing the responses of some 10,000 students enrolled in SENCER courses at collaborating institutions. By the end of the first five years of the project, SENCER's independent evaluators from the University of Colorado, Boulder, using data from the SALG, interview results and campus reports, found that "SENCER's goal of encouraging faculty to teach courses with civic content and innovative pedagogy is a reality." Their research also confirmed that SENCER reforms are durable with 92 percent of instructors believing that their courses would be continued in the future and 80 percent considered their courses to be a permanent part of curriculum.

What is being learned through this research and in the other assessment and knowledge-producing initiatives supported by SENCER expands our knowledge and contributes to the STEM knowledge base. Using these assessment tools and findings, collaborating faculty can





refine their approach to teaching on a continuous basis. Faculty report that having good assessment information establishes a climate of collaborative learning that is especially conducive to achieving SENCER ideals.

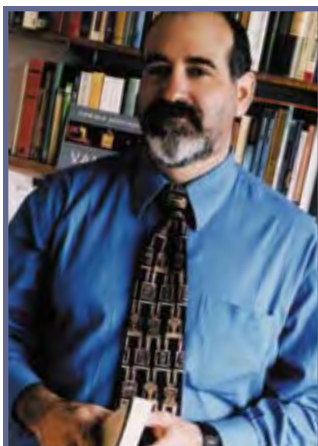
The assessment of learning is only one source of new knowledge. Other knowledge expansion and dissemination activities organized through SENCER and described in this section include our commissioned “backgrounders” (monographs that provide the general reader with a high-quality syntheses of complex civic issues that SENCER courses use to teach basic science), our online peer-reviewed journal, and our annual Washington Symposium and Capitol Hill Poster Session.

ASSESSMENT

SENCER commissions, adapts, develops, and disseminates a suite of assessment tools and resources. Assessment activities are coordinated by our national director of assessment and evaluation, who is supported by an

assessment advisory group. SENCER assessment interests and programs include initiatives in formative assessment, rubric development and validation, and learning research. The three major components, described below, include the Student Assessment of Learning Gains tool, the Scholarship of Teaching and Learning Program, and the Committee on Assessment for Student Achievement.

Our assessment program, like the larger SENCER program itself, promotes a “distributed leadership” model. Assessment projects benefit from the work of campus collaborators who either propose research projects or respond to our requests for research partners. Subsequently, they carry out approved research projects with the guidance of SENCER’s evaluation director and affiliated fellows. Scholars (including advanced undergraduate students and graduate students) desiring to pursue research studies of interest to the SENCER project are invited to contact the national office and the director of research and assessment, listed in an insert in the back of this viewbook.



SENCER is the nation’s most important reform initiative in general education and in higher education generally. It is addressing our country’s critical need for science education for the non-major in ways that address the intersections of scientific concepts, the STEM disciplines, and their social impact.

**—Edward Katz, Associate Vice Chancellor for University Programs,
University of North Carolina at Asheville**



Student Assessment of Learning Gains

The SENCER Student Assessment of Learning Gains (SALG) is an online, adaptable tool that allows students to rate how specific activities in SENCER courses help their learning. Students report on their general level of science skills and interests, as well as the civic activities in which they engage.

The primary purpose of the SALG is to provide useful, formative feedback to instructors interested in improving their teaching. Students rate how much class activities such as lectures, discussions, or labs help their learning. The SALG also provides a snapshot of student skills and confidence at the beginning and end of courses, allowing instructors to gauge the effectiveness of their instruction in specific areas.

Developed in collaboration with the SENCER project, the SALG is a free service open to all faculty, whether or not they are involved with SENCER. It is now maintained by the University of Wisconsin, Madison, with support from the National Science Foundation.

The aggregated results of individual SENCER-SALG implementations inform the national assessment of the SENCER program. All faculty affiliated with SENCER are encouraged to use the SALG, and all SENCER sub-awardees are required to use the instrument in connection with their course implementation projects.

Thus SENCER has access to a large database that can be used for evaluation and program improvement purposes. More information can be found at the website (<http://salgsite.org>).

Questions may be addressed to the SENCER-SALG coordinator at the address given in an insert in the back pocket of this viewbook.

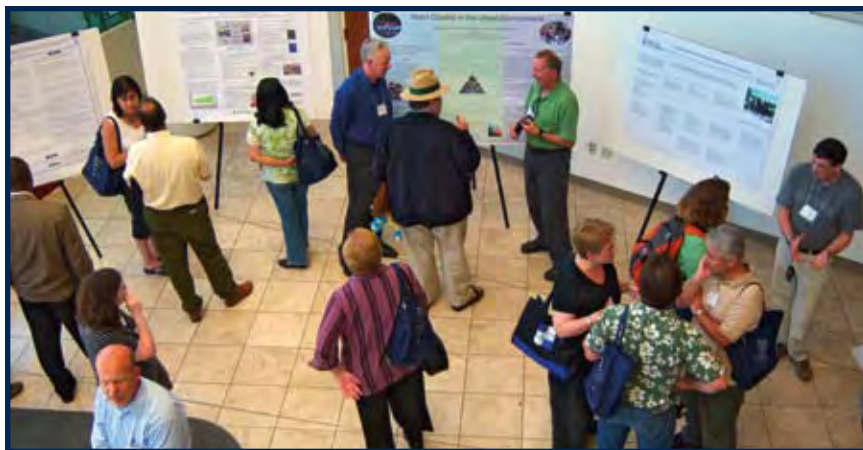
Scholarship of Teaching and Learning Program

The National Center for Science and Civic Engagement is a member of the Carnegie Academy for the Scholarship of Teaching and Learning Affiliates Program, an initiative to encourage and support institutions in the early stages of their commitment to the scholarship of teaching and learning (SOTL). NCSCE was invited to join by the Carnegie Foundation. As an affiliate, SENCER offers workshops on the scholarship of teaching and learning at regional and national symposia coordinated by Carnegie scholars connected to SENCER.

As a key element in its evaluation of SENCER, the NCSCE applies the scholarship of teaching and learning to the investigation of research questions about learning that arise during the maturation of the SENCER project. Faculty involved in the SOTL initiative conduct original research that helps answer more summative questions, while building and modeling a community of practice that embeds rigorous assessment research within a faculty member's routine professional practice. Inquiries may be directed to the SENCER SOTL research coordinator at the address given in an insert in the back pocket of this viewbook.

Committee on Assessment for Student Achievement

The Committee on Assessment for Student Achievement (CASA) is a group of educators committed to gathering, testing, and disseminating formative assessment techniques, strategies, and programs. Members collect and screen examples of formative assessment techniques from a wide variety of disciplines. Their goal is to create a growing collection of examples that cover diverse civic issues and course content, have relevance to as many



learning styles/goals and levels of courses as possible, and are sensitive and specific to the needs of all educational sectors. The resource collections will be published online on a periodic basis and incorporated in the digital library. Faculty interested in joining CASA or submitting formative assessment resources are invited to contact the coordinators at the addresses given in an insert in the back pocket of this viewbook.

BACKGROUNDERS

Backgrounders are commissioned papers in which scholars explore the wider range of issues that link science and complex civic challenges. The papers identify opportunities to use the best learning research in order to increase the likelihood that a course or program will achieve its intended goals. Topical backgrounders provide intelligent, general readers with high-quality syntheses of complex civic issues. Papers are published on the SENCER website and currently cover topics including hunger and public policy, the human genome project, nanotechnology, and biological diversity. Backgrounders have also been commissioned on cognitive science and science learning for non-majors, SENCER and quantitative literacy, the pedagogy of service learning, faculty transformation, and institutional change. Backgrounders are generally presented in draft form at our Summer Institutes and subsequently revised for publication and inclusion in the digital library.

WASHINGTON SYMPOSIUM AND CAPITOL HILL POSTER SESSION

The NCSCE's annual Washington Symposium and the SENCER Capitol Hill Poster Session gather educators,

students, and policy makers to address questions of student STEM learning on a local and national level. Specifically designed for members of the SENCER community with mature projects, the symposium provides opportunities for participants to present their campus-based work to members of Congress, Congressional staffs, and the general public. Students, traditionally more than one-third of the attendees, represent their own experiences as scholars in SENCER courses and as contributors to the development of new courses. In addition to sharing their work during a poster session and meetings on Capitol Hill, students and educators participate in work sessions on cross-cutting issues and new challenges.

SENCER especially seeks to include representatives from governmental and nongovernmental organizations in discussions on policy and collaborative efforts to improve courses. Organizations including the National Oceanic and Atmospheric Administration and the National Geographic Society have participated in discussions on how educators, nonprofit groups, and government agencies can coordinate the use of their vast reserves of real-time data to address civic questions and give students a broader view of how science, technology, engineering, and mathematics operate in the world.

At recent symposia academic leaders and distinguished public officials—such as former Assistant Secretary for the U.S. Department of Labor Emily Stover DeRocco, Congressman and Vice Chairman of the Agriculture Committee Tim Holden (Pa.), and Congressman Rush Holt (N.J.), a physicist and member of the Committee on Education and Labor—have helped frame themes on such topics as workforce development and the importance of citizen science.



SCIENCE EDUCATION AND CIVIC ENGAGEMENT: AN INTERNATIONAL JOURNAL

The National Center for Science and Civic Engagement founded and publishes *Science Education and Civic Engagement: An International Journal*. A direct outgrowth of the SENCER program, the mission of the journal is “to explore constructive connections between science education and civic engagement that will enhance both experiences for our students.” In the 21st century, mathematical and scientific reasoning is an essential element for full participation in a democratic society. Contributions to this journal focus on using unsolved, complex civic issues as a framework to develop students’ understanding of the role of scientific knowledge in personal and public decision making, along with examining how such knowledge is embedded in a broader social and political context. Since many pressing issues are not constrained by national borders, we encourage perspectives that are international or global in scope. In addition to examining what students learn, we also explore how this learning takes place and how it can be evaluated, documented, and strengthened. By exploring civic questions as unsolved challenges, we seek to empower students as engaged participants in their learning on campus and as citizens in their communities.”

The *Journal* is a web-based, peer-reviewed publication released twice per year. Published articles include topical reviews, research studies on teaching and learning, and connections between science education and public policy. Issues of the *Journal* can be downloaded for free at www.secej.net.

DIGITAL LIBRARY

The SENCER Digital Library, launched in 2008, houses the growing collection of courses and programs in the model series, backgrounders, short essays, e-news articles, course materials, and other materials produced by the SENCER project and our campus partners. The library allows visitors to perform advanced searches, which can be customized by learning strategy, assessment tool, civic issue, or subject discipline.

It was constructed in a collaborative effort that involved leaders of the Science Education Research Center (SERC) at Carleton College, students and faculty from the School of Information and Library Sciences at Rutgers University, and SENCER staff. The Digital Library, which is hosted by SERC, can be accessed freely by using the search features on every menu on the SENCER website (www.sencer.net).



Connecting Math to Civics

"In our course, 'civic' takes on a very local interpretation."

*—Thomas M. Zachariah, Suzanne Larson,
and Jacqueline M. Dewar*



Mathematical concepts can often seem abstract to students in the classroom. However, when these same students apply math to real-life problems, abstract concepts can take on an astonishing clarity.

And that is the ultimate goal of Loyola Marymount's "Math 102: Quantitative Literacy Through Community-Based Group Projects," a course in which students use traditional mathematics to solve real-world questions.

Questions are culled from issues that directly affect members of the campus or local community and have included topics ranging from an analysis of Social Security receipts and payments to a comparison of on-campus and off-campus living expenses.

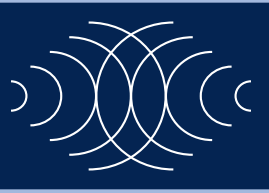
Using mathematical concepts such as number sense, elementary statistics, mathematics of finance, and computer spreadsheets as tools, students investigate their particular problem in the hope of connecting their classroom learning with the "real world."

Pioneered by Thomas M. Zachariah, Suzanne Larson, and Jacqueline M. Dewar, all of LMU's Department of Mathematics, the course teaches "to basic science and mathematics *through* complex and unsolved public issues," according to the trio of professors.

"In our course, 'civic' takes on a very local interpretation," says Zachariah.

The value of the course is that it prepares students to address the problems and challenges of the larger society and world in which they live by using mathematics as a tool. This enables students to connect theory and practice and bring knowledge to bear on real-world problems.





supporting **INNOVATION**

SENCER encourages innovation and welcomes practitioners to bring their work forward in a variety of settings and communities. This democratic gesture gives collaborators an opportunity to present their work for inspection and appraisal by others. It invites a broader community to explore new problems and discover new answers. The public, peer-review approach, conducted with transparency and integrity, not only supports our goal of pedagogical and thematic innovation, but also models the best in democratic and scientific practice. SENCER recognizes the contributions of our collaborators to help them to sustain their innovations.



Remaining open to new ideas and new combinations of ideas is part of the SENCER ethos. There are always ideas bubbling up from around the community as people try new things, find that they do or do not work, make the appropriate adjustments, and then go forward. In the SENCER community, innovation applies to our process and our product.

Many of SENCER's longtime collaborators have claimed that the biggest change participation in the SENCER project makes is in the teaching practices of the participating faculty members themselves. A psychologist who has observed the SENCER program over a long period notes that participation in SENCER "results in a transformation of not only students and courses, but of the people who are doing the teaching. Once they apply this approach, they are unable to return to pedagogical strategies that often prized abstraction over application and confused high failure rates with rigor. Nothing beats the combination of improved learning, improved

grades and students who are no longer wondering 'what do I need to learn this stuff for anyway?'"

SENCER is committed to supporting campus innovations that increase the STEM knowledge base, broaden the impact of campus work beyond its local setting, and result in the kind of faculty transformation described above. We promote innovations through formal sub-award grants and recognition programs. Less formally, we assist campus collaborators through consultations and campus visits, by participation in tenure and promotion review processes, and through sponsorship of dissemination activities by campus partners.

AWARDS

Post-Institute Implementation Awards

SENCER annually awards NSF-supported sub-grants to institutions that have sponsored team attendance at a SENCER Summer Institute and that successfully complete a competitive application process. Grants—modest in





scale but often bold in effect—are awarded for two-year terms to support projects such as course/curriculum designs or redesigns, faculty development efforts, and inter-institutional partnerships. Institutions that have received prior implementation awards are eligible for additional support only for significant project expansion to other courses or for wholly new ventures.

Since the inception of the project, SENCER has made more than 200 sub-awards to colleges and universities for team-based projects. As a result, hundreds of courses have been launched or redesigned. Because the implementation award project leaders are required to assess progress formatively and summatively according to the goals and learning outcomes established in their applications, several prior awardees have been able to use the sub-awards as pilot projects. They have subsequently leveraged their results to garner major funding from their own institutions, from foundations, and from government organizations such as the National

Science Foundation and the National Institutes of Health. These funds have been used for program expansion, refinement, and scaling so that projects reach more students and communities.

The William E. Bennett Award for Extraordinary Contributions to Citizen Science

The William E. Bennett Award was established in 2009 to honor extraordinary contributions to citizen science, as understood broadly within the SENCER context. The award celebrates the career and post-career work of Bill Bennett, former senior science adviser to the Secretary of the U.S. Department of Health and Human Services and senior scholar for SENCER and NCSCE.

Bennett was the first recipient of the award, which was inaugurated at the Washington Symposium and Capitol Hill Poster Session. Through his work as a scientist, educator, science administrator, and senior advisor, Bennett has advocated for and worked toward



SENCER has captured the imagination of professors and administrators as they have looked for ways to improve the quality of science education for non-science majors. SENCER has effectively developed models that have provided templates that assist professors in bringing new ideas into their classrooms.

**— Marion Field Fass, Professor of Biology
and Professor of Health and Society, Beloit College**



a public engaged in the science, technology, engineering, and mathematical components of policies and civic issues.

The award will be made annually to a person or persons for extraordinary achievements in fostering students' capacities to engage in science, technology, engineering, and mathematics and to apply their knowledge, skills, and energies to an issue of civic consequence.

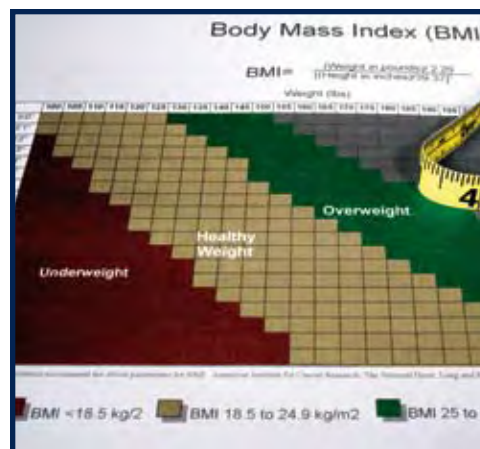
CONSULTATIONS AND HOUSE CALLS

SENCER supports members of the academic community by providing expert assistance for course and curricular innovations. Often this is accomplished through telephone consultation, referrals to faculty and academic leaders who can help, a review of materials, and feedback on drafts of curricular, grant, and other proposals. Sometimes, however, campus personnel conclude that a personal visit—a “house call”—by someone with direct

experience and knowledge of SENCER is what is really needed. The SENCER national office staff is available to help arrange house calls, which generally consist of a half-day, daylong, or two-day campus visit by a member or members of the SENCER core staff, a leadership fellow, model developer, or other senior leaders for intensive work with a group of faculty, administrators, and, when possible, students. Campus visits often also include a short session or workshop with larger groups of faculty for an introduction to SENCER or a primer in a certain type of pedagogy.

Leaders in the SENCER community have helped faculty and administrators with faculty development, large-scale curriculum reform, introductory and STEM majors courses, the development of topical courses (e.g. health, environment), and the infusion of civic engagement into existing courses.

Host institutions are responsible for providing travel and lodging support for the consultant, and honoraria





may be negotiated. (The principal investigator and associate director of SENCER do not accept honoraria for house calls.)

LETTERS OF SUPPORT

SENCER frequently provides tangible assistance to its members by writing letters of recommendation and appraisal for those seeking grant funding, tenure, promotions, or fellowships. In doing so, we recognize the innovations developed by members of the SENCER community and help our campus collaborators obtain the status, recognition, and internal and external support needed to sustain their innovative work.

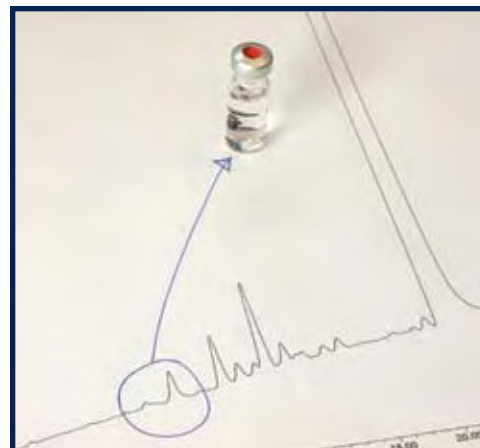
BROADENING IMPACTS AND DISSEMINATION

SENCER provides support and funding for campus partners to organize symposia, presentations, and poster sessions at regional and national disciplinary meetings and

conferences. These have included sessions at meetings of the American Association for the Advancement of Science, the American Chemical Society, American Society for Cell Biology, American Society for Microbiology, the Association of American Physics Teachers, regional Campus Compacts, the League for Innovation in the Community College, and the Mathematical Association of America, as well as state academies of science. The national office also accepts invitations from organizations that desire to have SENCER programs as part of their annual meetings or regional workshops.

The SENCER program has been featured in publications of disciplinary societies and associations, as well as educational and professional journals. Information has been disseminated to the general public through newspaper articles, television and radio programs, publications for college alumni, presentations to community organizations, visits and consultations at schools, and museum exhibitions.





AREAS OF EXPANDING INTEREST AND INNOVATION

As noted throughout this publication, SENCER supports a burgeoning community of learners, scholar-students, faculty, educators, academic leaders, and representatives from both governmental and nongovernmental organizations who share a commitment to improving learning and building civic capacity.

Cross-cutting issues that animate the dimensions of SENCER's current and future work include:

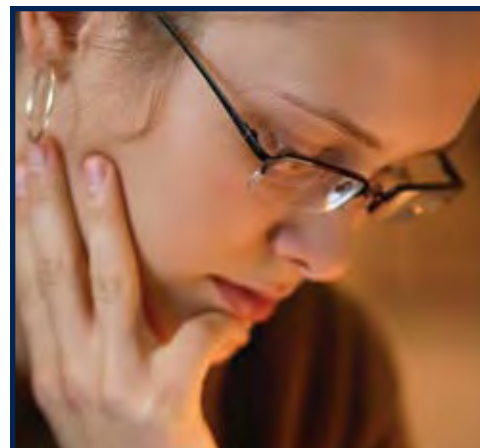
- Increasing the level of science and mathematics learning achieved in SENCER courses and connecting this knowledge to workforce challenges;
- Using the SENCER approach to attract more students to pre-service teacher education (especially at the elementary school level) and exploring the feasibility of developing primary and secondary school

SENCER courses and curricular projects in college-level courses;

- Extending the SENCER approach to the education of STEM majors and in other non-STEM curricular areas;
- Using the diverse SENCER community to strengthen connections between community and four-year colleges; and
- Exploring the communities of interest among those working in formal and informal science education.

AN INVITATION

The SENCER program counts on its "members" to contribute to the intellectual capital of the project by producing knowledge and sharing their insights, resources, and assessments. We invite your interest and involvement with our existing work and the initiatives now in the planning stages.



“With students and faculty from the physical sciences, social sciences, and humanities, class participants are challenged to consider ‘foreign’ approaches to a problem and acknowledge that sometimes the best answer springs from a fusion of perspectives, both within and beyond their field of study.” — Jennifer Stuart '09



Despite its extensive healthcare system and technological advances, why does the United States rank 28th in the world in infant mortality, the second lowest ranking in the developed world? That question is central to a course at Franklin & Marshall that examines the pressing civic problem of this country's poor pregnancy outcomes. The course, “Pregnancy Outcomes in American Women,” is team taught by biologist Kirk Miller, statistician Berwood Yost, gender historian Alison Kibler, and economist Sean Flaherty.

The quartet use locally collected data and a multidisciplinary approach to let students examine topics such as infant mortality and its prevention; stages of human pregnancy; genetic testing; and the impact of pharmaceuticals, toxins, and nutrition on fetal development. Students explore unanswered questions at the intersection of science and public policy: “What is good prenatal care and does access to it improve health outcomes?” and “When does the fetus become a person with rights equal to the mother's?”

An overarching goal of the course is to give students experience with the evaluation and use of evidence drawn from multiple sources, so that the construction and defense of arguments can be based on statistical data.

Jennifer Stuart '09, a former student of the course currently in the Harvard School of Public Health's master's program in epidemiology says: “With students and faculty from the physical sciences, social sciences, and humanities, class participants are challenged to consider ‘foreign’ approaches to a problem and acknowledge that sometimes the best answer springs from a fusion of perspectives, both within and beyond their field of study.”



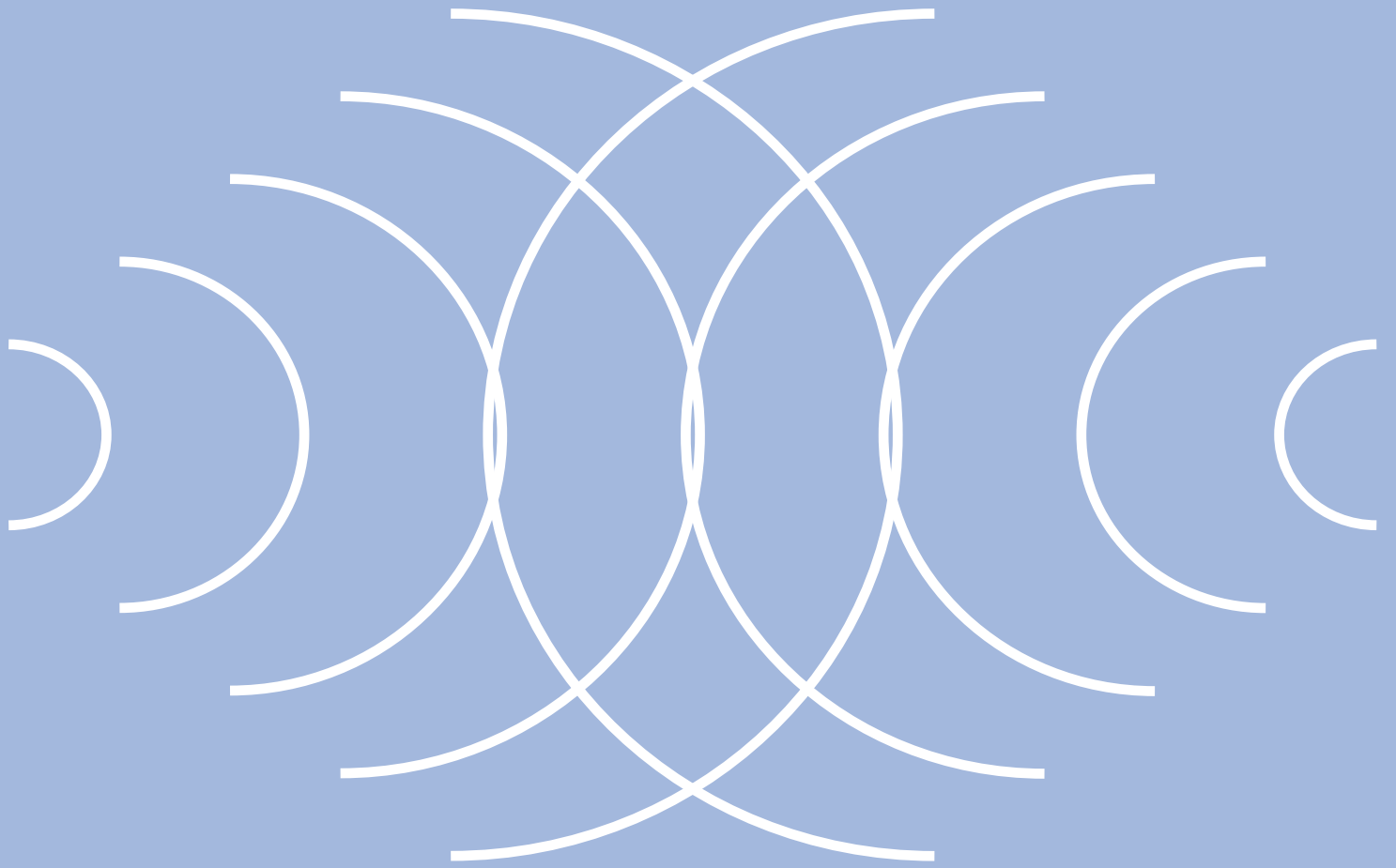
captions & CITATIONS

CAPTIONS

- Page 7, bottom: Ellen Goldey, SENCER Leadership Fellow, Professor of Biology, Wofford College. Photo courtesy of Ellen Goldey.
- Page 9, top left: Gili Marbach-Ad (Assistant Professor and Director, Center for Teaching and Learning, College of Chemical and Life Sciences, University of Maryland) and Daniel C. Stein (Professor of Cell Biology and Molecular Genetics, University of Maryland) at the ncsce's annual Washington Symposium. Photo by Alyssa Bloom.
- Page 10, top left: Students in the Model course "Science on the Connecticut Coast" examine samples in the Southern Connecticut State University lab. Photo courtesy of SENCER Leadership Fellow Vincent Breslin.
- Page 11, top: Top: Southern Connecticut State University students from the course "Science Along the Connecticut Coastline" aboard the *R/V Sounder* in New Haven Harbor. The students used a ponar grab to collect sediment samples from throughout the harbor to determine possible copper contamination. Also shown are Professors James Tait (red coat, fourth from left) and Vincent Breslin (blue windbreaker, sixth from left). Photo courtesy of Vincent Breslin.
- Page 14, top right: Summer Institutes are invitational, intensive residential experiences for educators and administrators who desire to re-organize courses and curricula around relevant civic issues to improve student learning, specifically in STEM disciplines. Photo of 2008 Summer Institute participants by Katie M. Shade.
- Page 15, bottom: Ann Q. Staton, Dean of the College of Arts and Sciences, Texas Woman's University. Photo courtesy of Texas Woman's University.
- Page 19, top: LEFT TO RIGHT: Jason Reynolds, a biology major at the University of South Carolina, Sumter, and Jill Palchinsky, a biology major at Meredith College, participate in a service learning project collecting clinical data at Rachel's Children's Home in Kenya as part of NSF-CCLI grant DUE0510368. Photo courtesy of John Mecham.
- Page 19, bottom: John Mecham (center), Professor of Biology, Meredith College, and SENCER Senior Leadership Fellow, works with medical students at Kenyatta University, Nairobi, Kenya, as part of the Fulbright Scholar Program of the Council for International Exchange of Scholars. Photo courtesy of John Mecham.
- Page 23, bottom: Edward Katz, Co-Director, Center for Innovation (South); SENCER Senior Fellow; and Associate Provost and Dean of University Programs, University of North Carolina at Asheville. Photo courtesy of UNC Asheville News Services.
- Page 25, top left: Poster sessions are an integral part of the Summer Insitututes. Photo of the 2008 Summer Institute poster session by Katie M. Shade.
- Page 25, top right: The U.S. Capitol. Photo courtesy of Michael Andrus, participant in the Washington Symposium and Capitol Hill Poster Session.
- Page 27: Students in the Model course "Math 102: Quantitative Literacy Through Community-Based Group Projects Through Community-Based Group Projects," participate in an insect survey. Photo courtesy of Thomas M. Zachariah.
- Page 31, top right: SENCER co-founders David Burns and Karen Oates present William E. Bennett with the inaugural award established in his honor at the 2009 ncsce Washington Symposium. Bennett is former senior science adviser to the Secretary of the U.S. Department of Health and Human Services, a Senior Scholar for SENCER and ncsce, and a Senior Scholar on the ncsce Assessment Advisory Committee. Photo by Alyssa Bloom.
- Page 31, bottom: Marion Field Fass, Co-Director, Center for Innovation (Midwest); Professor of Biology and Professor of Health & Society, Beloit College. Photo courtesy of Beloit College Office of Public Affairs.
- Page 35: LEFT TO RIGHT: Franklin & Marshall's Berwood Yost (Director, the Floyd Institute's Center for Opinion Research and Institute for Public Policy Analysis), Alison Kibler (Associate Professor of American Studies and Women & Gender Studies), Kirk Miller (the B.F. Fackenthal Jr. Professor of Biology), and Sean Flaherty (Professor of Economics) team teach the Model course, "Pregnancy Outcomes in American Women." Photo by Marcy Dubroff.

CITATIONS

- Page 8 Seymour, Elaine, and Nancy M. Hewitt. *Talking about Leaving: Why Undergraduates Leave the Sciences*. Boulder, Col.: Westview Press, 1996.
- Page 8 Bransford, John D., Ann L. Brown, and Rodney R. Cockling, eds. *How People Learn: Brain, Mind, Experience, and School*. Washington, D.C.: National Academy Press, 1999.





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