

# Green Service-Learning Across the Curriculum: Model Courses at an Urban Research University

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## Abstract

*The authors contend that service-learning courses at urban universities can and should play a vital role in the greening of higher education and the promotion of sustainable urban environments. They describe one model outreach program that provides continuing education for middle school teachers and several undergraduate-level courses from disciplines across the humanities and sciences at Virginia Commonwealth University. The authors outline strategies for implementing these green service-learning courses and discuss the value of offering a green curriculum that includes both science and humanities courses.*

Virginia Commonwealth University (VCU) is a large urban public, doctoral-granting research university that enrolls more than 32,000 students in 208 certificate and degree programs. Located in the heart of the capital city of Richmond on two downtown campuses, VCU has a long history of commitment to community partnerships and was one of the first universities in the nation to be recognized by the Carnegie Foundation as a community-engaged campus. The university's strategic vision, as outlined in *VCU 2020 Vision for Excellence*, is built on five core themes, one of which is to maintain VCU as a model for university-community partnerships. This commitment was recently recognized in the 2009 national "*Best Neighbor*" *Colleges and Universities* survey, which ranked VCU 11th in the nation (Watson 2009). In his 2008 article in the *Chronicle of Higher Education* entitled "Even in Hard Times, Colleges Should Help Their Communities," VCU's president Eugene Trani noted the critical need for universities to establish and extend university-community partnerships during difficult economic times. He states,

Twenty or even 10 years ago, universities may have pared back their community-engagement activities in periods of fiscal uncertainty on the grounds that they were valuable expressions of the university's social commitment but not essential to teaching students and contributing to the scholarly community. But today we need to engage with our communities to meet our instructional goals, equip our students with discernment and judgment, and enable them to be productive citizens. Moreover, collaborative partnerships are a vital part of a university's research portfolio. (Trani 2008)

During the early 1990s, administrators at VCU began to recognize service-learning as an effective learner-centered pedagogy and to formally identify courses that incorporated high quality service-learning pedagogy. VCU faculty members who were known to use other learner-centered pedagogies were invited to integrate service-learning into their courses. For the past ten years, VCU graduate and undergraduate courses that meet specified quality criteria are formally designated as service-learning (SL) courses in the university's Schedule of Classes as well as on students' transcripts. The staff of the university's Service-Learning Program Office, which is housed in the Division of Community Engagement and operates independently from all academic units, oversees this designation process, provides professional development for faculty members who are interested in using service-learning in their courses, facilitates community partnerships for service-learning courses, operates a service-learning teaching assistants program, and fosters service-learning scholarship and community-based research. The office is currently staffed by a Ph.D.-level professional faculty member who serves as full-time director. The director reports to the vice provost for Community Engagement, who reports to the provost. The director is assisted by a twenty-hour-per-week graduate assistant; and each semester, approximately thirty unpaid undergraduate teaching assistants support faculty members who teach designated service-learning courses. The university currently provides the Service-Learning Program Office with an annual budget of approximately \$150,000.00. This budget pays for the director's salary and fringe benefits as well as all program expenses related to the graduate assistantship, faculty development stipends, computer/equipment needs, supplies/books/journals, and travel. General operating expenses (e.g., office space, photocopying, telephone, mailing, etc) are paid for by the Division of Community Engagement. Additional funds to support the program office are sought through external grants and contracts competitions. More information about the activities of the VCU Service-Learning Program Office can be found at <http://www.community.vcu.edu/solutions/servicelearning/>.

Through their enrollment in service-learning courses, many VCU students have become involved in green projects within the urban communities that surround the university. Community partners for these service-learning courses have been primarily public schools and nonprofit organizations, although several courses have partnered with state park systems and other governmental offices. VCU's green service-learning courses are offered within a variety of academic disciplines in both the humanities and sciences; yet all of these courses share the common goal of expanding students' understanding of the complex, dynamic, and synergistic interrelationships of living systems and of the potential impact of an engaged ecoliterate citizenry. Within each of the green service-learning courses described in this paper, students are encouraged to develop and practice ecoliteracy, which Fritjof Capra defined in his lecture, *Ecoliteracy: The Challenge for Education in the Next Century*, as "understanding the basic principles of ecology and being able to embody them in the daily life of human communities" (1999). VCU's green service-learning initiatives have also sought to foster ecoliteracy in younger students by implementing an innovative outreach program for public school teachers. The externally funded model outreach program described in

this paper (i.e., GreenSTEM@VCU) is designed to increase middle school teachers' knowledge of service-learning pedagogy and new green technologies and to raise their awareness of environmental issues and green job opportunities. Teachers are then supported in creating and implementing high-quality integrated STEM (Science, Technology, Engineering, and Math) service-learning lessons for their own students within the communities where they teach and live.

In the next sections, we will describe these green service-learning courses and outreach projects, and we conclude the article with a discussion of the implications of these initiatives for the future of our own university and for other urban universities across the country.

## **Model Green Service-Learning Courses**

All designated service-learning courses at VCU require each enrolled student to complete a minimum of twenty hours of meaningful community service per semester and to reflect on the connections between classroom and community-based learning. The following sections provide a description of the learning objectives, course structure, reflection assignments, service activities, and evidence of impact for four green service-learning courses.

### **Introduction to Human Geography (GEOG 102) and World Regions Geography (GEOG 303)**

Human-environment interaction is central to geographical thought. Human-environment interaction does not view the environment as the backdrop or stage for human activities but rather sees the environment and humans interacting together. At times, the environment dominates over human activities, as we see in naturally occurring events that cause harm to humans. In other cases, humans dominate the environment, often with resulting degradation. This section of the article discusses two green learning activities in which students address the negative impacts of human activities on the environment and make positive changes.

Introduction to Human Geography (GEOG 102) and World Regions Geography (GEOG 303) are two 3-credit-hour undergraduate-level courses offered through the Urban Studies and Geography program of the university's Wilder School of Government and Public Affairs. Students in GEOG 102 are primarily undergraduates in the elementary education major and students in the Urban and Regional Studies (Geography) major. The course is required for these two majors. Approximately 100 students enroll in GEOG 102 and it is offered each semester. Students in GEOG 303 are primarily graduating seniors and are enrolled in the course because it meets multiple general education requirements. Approximately twenty-five students enroll in GEOG 303, which is taught during the fall semester.

In both GEOG 102 and GEOG 303, students complete a brief Environmental Footprint Survey (available from the authors) at the beginning of the semester. This survey is

designed to assess the impact of their lifestyles on the environment. After completing and scoring the survey, students define three separate practices to lighten their footprint. They engage in these practices throughout the semester and complete an evaluation at the end of the semester which follows the “what,” “so what,” and “now what” themes of the standard reflection format used in best practices service-learning courses. The Environmental Footprint Survey is becoming a key instrument for engaging students by providing them with a thought-provoking method for examining and lightening their own individual environmental footprints.

The second green activity relates to service-learning in both courses. The Reedy Creek Clean-Up is one of several options presented to students and approximately twenty percent of the students enrolled in GEOG 102 and GEOG 303 select this project option. Students participating in the Reedy Creek Clean-Up project spend most Saturday mornings throughout the semester picking up trash along and in the channel of an urban stream. The three reflection assignments they submit (two written and one oral) require students to focus on the role that pollution in one small stream plays in the environmental report card of the Chesapeake Bay, of which it is a tributary. Students who select this option synthesize their service-learning work with issues raised on the Environmental Footprint Survey activity listed above, thereby integrating learning across multiple sources. Approximately seven cleanups occur during the semester with an average of twenty large garbage bags of trash collected at each cleanup. Roughly half of the trash is sorted out for recycling, resulting in seventy bags of trash that will not flow into the Chesapeake Bay and seventy more bags of recyclable materials each semester.

An additional spring activity associated with this service-learning option links the GEOG 102 students with one of the city public elementary schools. The school lies just two blocks from the wetlands for Reedy Creek. During each spring semester GEOG 102 students organize and manage the school’s annual environmental festival, which is held during the April Parent-Teacher Association evening meeting at the school. The VCU students assist in teaching children and their parents about wetlands conservation, participate with children in making a recycled objects art project, accompany children to the wetlands for nature study and cleanups, and supervise other environmental learning centers.

The impact of the Reedy Creek Clean-Up, now in its tenth year, has shown exciting ripple effects throughout the university, community, national environmental organizations, and urban public school system. The elementary school requests that VCU students stage the environmental festival annually. The Reedy Creek Clean-Up has earned important recognition from the local Sierra Club, city councilmen and councilwomen, and the local police, who assist by enforcing city trash/dumping codes. The Reedy Creek Clean-Up project has opened doors for important funding opportunities. Collaborative work between VCU faculty and Virginia state agencies has garnered over \$25,000 in funding for educational supplies and water monitoring apparatus. Additional funding has been awarded through a partnership with a nonprofit organization, Alliance for the Chesapeake Bay (<http://www.alliancechesbay.org/>). VCU

student participation and public school involvement in the Reedy Creek Clean-Up project provide excellent equity matches for grant dollars.

A citizens' action group, once dormant, has been revived because of the project. Motivated and capable university student workers provide an asset for the Reedy Creek Coalition community group as it defines its goals and outcomes. The citizen group is now focusing on storm water audits on residential structures in the creek's watershed and continues to monitor the health of the Reedy Creek water. VCU service-learning students in GEOG 102 and GEOG 303 provide the needed labor to implement these audits (Chris French, "Richmond community mobilizes to reduce stormwater," December 2009; <http://www.bayjournal.com/article.cfm?article=3729>).

Two peer-reviewed publications (Aspaas 2008; Aspaas and Parece 2007) have resulted from this work and two more are in the draft stages with students as coauthors. Both of the peer-reviewed publications provide an analysis of the pedagogy involved in completing outdoor environmental work.

An analysis of student responses to formal and informal assessment suggests that participation in these two green learning activities is viewed as beneficial. Student responses to the Environmental Footprint Survey are informal and anecdotal. One student reported the impact of the readings on her life and how, having accomplished her footprint goals, she felt that she could look the author in the face and state that she was making her very best effort to lighten her footprint.

Course evaluation data from students who participate in the Reedy Creek Clean-Up project (which includes the three reflection assignments) are highly positive. In 2008, 52 percent of students agreed or strongly agreed that the service-learning work increased their understanding of the readings and course content. Sixty percent agreed or strongly agreed that the service-learning component helped them clarify professional goals. Seventy-seven percent agreed or strongly agreed that as a result of the service-learning course, they felt more connected to the community, and 68 percent expected to continue to be involved with their service-learning placement.

These two green learning activities appear to be sustainable at the university and within the community. Students evidence pride in accomplishing something good for the environment. Visibility in and support from the community builds student pride in their work and for their university. These two service-learning courses will continue as important pathways for helping undergraduate students understand the human-environment interaction that lies at the core of the geography discipline.

### **Global Ethics and World Religions (RELS 340/INTL 342)**

Global Ethics and World Religions (RELS 340/INTL 342) is offered every semester as a cross-listed 3-credit-hour service-learning course through both the Religious Studies program and the International Studies program in the VCU School of World Studies. Each semester the service-learning sections of this course enroll approximately 160

third- and fourth-year undergraduate students representing a variety of backgrounds and majors.

In *Seeds of Peace: A Buddhist Vision for Renewing Society (1992) and Conflict, Culture, Change: Engaged Buddhism in a Globalizing World (2005)*, Thai Buddhist scholar Sulak Sivaraksa elaborates on the work of cultivating peace within ourselves by practicing mindful-living and cultivating peace in the world by constructing a way of life and model of development that is socially just, generous, and sustainable. In RELS 340/INTL 342, students take Sivaraksa's hopeful proposals to heart by studying how scientific, philosophical, religious, and aesthetic ideas about nature shape our interactions with the world and by working with community members on projects that replenish and preserve local urban ecosystems. The combination of "walled" and "unwalled" study enlarges and enlivens the field of learning, involves students in auditory, kinesthetic, logical, linguistic, experiential, and interpersonal forms of learning, and helps students cultivate a deeper capacity to repair the earth. Students move from being primarily passive recipients of existing knowledge to active participants in the creation of new knowledge and ways of acting as democratically engaged citizens who thoughtfully assume responsibility for building a sustainable society.

Throughout the semester students write brief reflection-response papers on the readings, videos, and lectures; keep a field journal in which they carefully describe and creatively explore the connections between what they are learning in class and what they are learning in the community; and make a class presentation on their community project. We begin the course by reading scientific reports on the state of the world's ecosystems and reflect on the significance of these reports in light of Ralph Waldo Emerson's ideas regarding the spirituality of nature, John Muir's reflections on the place of humans in the web of life, and Aldo Leopold's land ethic. Students consider these ideas in relationship to what they are learning through their ecological community projects. These community-based projects include working with such nonprofit and governmental organizations as the Chesapeake Bay Foundation (<http://www.cbf.org/>), the James River park system (<http://www.jamesriverpark.org/>), the Sierra Club (<http://virginia.sierraclub.org/>), and Tricycle Gardens (<http://tricyclegardens.org/>).

Students working with the Chesapeake Bay Foundation explore how expanding our ethical concern beyond human beings to include, as Leopold counsels, the land, air, water, plants, and animals might help improve the condition of Virginia's lakes, rivers, estuaries, and bays. In their study of indigenous religious traditions, students reflect on what nature teaches them, in the words of Chief Luther Standing Bear, regarding the "mysteries of life." How might shifting from a worldview in which humans occupy the highest rung on the "ladder of creation" to a worldview that affirms our kinship with creation affect our understanding of and approach to development? After reading about the philosophy of haiku poetry and sharing their own poetry while visiting a Japanese garden, students contrast that experience with their aesthetic experience at school, work, and home. Students write about the benefits of integrating nature more harmoniously into the human-constructed environments such as neighborhoods,

workplaces, and universities. How can we green the urban environment so that cities and nature exist in a more balanced relationship with each other? While studying Jewish, Christian, and Islamic views on caring for creation, students consider and write about how adopting this ethic might change the way we view such practices as mountaintop removal, a practice they learn about first-hand while working with the Sierra Club on issues related to environmental toxins and sustainable energy.

A primary goal of the course is to foster the art of making connections between the scientific, sociological, philosophical, religious, and cultural ideas we explore in class and the work students are doing in the local urban community. The journal assignment prompts students to make connections between in-class and in-community learning and to do so through diverse forms of expression, including poetry, photography, drawings, and short stories. In this way, the journals provide students with a way to connect intellectual and imaginative approaches to the world. Instructor-generated questions stimulate this exploration. How might David Suzuki's idea of establishing a "sacred balance" between humans and nature change our definition of the concepts of "the good life," "progress," and "happiness"? Would doing so mean shifting from a society organized around what Sivaraksa calls the "religion of consumption" to a society organized around appreciation and care for the earth's ecosystems? In response to questions such as these, students creatively articulate the connections between the scientific and spiritual dimensions of the work they are doing. In doing so, they not only connect different ways of knowing the world, they reinvigorate what Harvard biologist E.O. Wilson calls *biophilia*, humanity's innate sense of kinship with and affection for the natural world, a sense and affection often suppressed and marginalized in a society disconnected from the rhythms, cycles, and sensual beauty of nature.

Especially relevant to the work of cultivating Sivaraksa's "seeds of peace" is the collaboration between students and the nonprofit organization Tricycle Gardens. Working with members of Tricycle, students help build and maintain community gardens (including children's learning gardens), which offer opportunities to learn about and enjoy, literally, the fruits, as well as vegetables, herbs, and flowers. This work brings students and city residents together around the art of gardening. The gardens provide much needed local sources of fresh, organic food and strengthen bonds between children and adults as they reconnect with nature, enjoy the beauty of life, and share the pleasure of the good food they have grown.

Over the past three years, RELS 340/INTL 342 students have helped Tricycle Gardens and Richmond residents build seven flourishing community gardens. This work has enriched students' knowledge and understanding of the interrelationships between food security, environmental degradation, public health, and their own place in the ecological and social web of local life. They not only learn about these interrelationships, but also work closely with community members to improve social and natural conditions of local life.

Students find gardening, and especially gardening with children, a real joy. They return to the classroom with humorous and heartwarming stories about kids digging in the

dirt, watering plants (and each other), and happily eating and sharing what they have grown. Because of their involvement with community gardens, students feel more committed to caring for the communities and ecologies that compose the ever-changing mosaic of Richmond. Many students have started their own gardens and become more involved in the work of greening their own lives, VCU, and the urban environment. Meanwhile, many of the children express great delight in their new college friends and a desire to go to college when they “get bigger.” This project has succeeded because of the university students’ ability to continue with the project during fall, spring, and summer semesters. This continuity enables the relationship between enrolled students and local garden communities to extend throughout the planting, growing, and harvesting seasons.

RELS 340/INTL 342 provides students with multilayered opportunities to develop a deeper sense of connectedness to and responsibility for the evolving biotic community in which they live. The course enables students to figuratively and in some cases literally “put down roots.” It encourages mindful-living in relationship to nature and contributes in a small way to the creation of a socially just, peaceful, and sustainable way of life. As one student remarked, “caring for the James River and working in the gardens makes Sivaraksa’s seeds of peace really come alive.”

### **Ecological Service-Learning (BIOL 497)**

Ecological Service-Learning (BIOL 497) is a 1-credit course that is offered to students who are concurrently enrolled in the BIOL 317 General Ecology course. BIOL 497 is offered every semester. Approximately sixty students enroll annually as an elective to supplement and enhance the learning experience of the lecture course BIOL 317. Students in the course are typically third- or fourth-year undergraduates representing a variety of majors. BIOL 497 was developed as a way to stimulate and cultivate ecological and environmental literacy using a hands-on, field-based, out-of-the-classroom experiential learning environment for our undergraduate students. Students in BIOL 497 meet as a group once a week for recitation and spend several hours each week in the community completing environmental service projects. They also attend weekly lectures for BIOL 317 and complete all assignments related to this course. BIOL 497 students become actively engaged in ecologically based service projects for a variety of local, regional, and national organizations. In addition to educating local public school children and the general public about current ecological issues, BIOL 497 students provide critical data collection in the field and contribute to several long-term ecological monitoring projects for the various community partners. The BIOL 497 students reflect on the connections between theories and processes presented in their BIOL 317 General Ecology course lecture and their BIOL 497 community service-learning activities through three reflection journal papers, instructor-facilitated in-class discussions, online discussion forums, and a final synthesis paper.

The primary objective for BIOL 497 is to empower our students with a fundamental understanding of the science of ecology so they can become informed citizens engaged in finding solutions to the global environmental problems confronting society today.

Additional objectives of this course are to (1) facilitate a service environment designed to enhance the learning process, (2) promote a hands-on experience for students, (3) teach students the relevance of ecology as it applies to real-world situations through assisting community partners, and (4) allow students to personally explore the interaction of human and natural systems.

BIOL 497 students participate in activities with a variety of governmental and nongovernmental organizations found throughout the Richmond metropolitan area. During spring semesters, students have the opportunity to engage in data collection and ecological monitoring of birds, mammals, amphibians, reptiles, terrestrial and aquatic macro-invertebrates, fish, fungi and vegetation within two Natural Area Preserves owned by the Virginia Department of Conservation and Recreation (VADCR) Natural Heritage Program. All data collected is incorporated into the VADCR Natural Heritage Program database for these preserves, which helps VADCR evaluate changes in biodiversity over time. Every fall semester students have the opportunity to participate in the Ocean Conservancy's International Coastal Cleanup at Wreck Island Natural Area Preserve on Virginia's Eastern Shore. The data students collect on marine pollution is then used by the Ocean Conservancy and Clean Virginia Waterways to help shape legislation to reduce pollutants entering into aquatic ecosystems. BIOL 497 students participate in World Water Quality Monitoring Day, when they educate the public on the importance of clean waters while teaching chemical and biological water quality monitoring techniques.

Students in BIOL 497 participate in and contribute data to several long-term ecological research programs. The first involves helping local middle and high school students build and install Prothonotary Warbler nest boxes within the Lower James River Wetlands Audubon Important Bird Area, building on research begun in 1987 by VCU scientists to provide critical nesting habitat for a declining neotropical migratory bird species. A second project is The Virginia Box Turtle Monitoring Program initiated by the Virginia Department of Game and Inland Fisheries to help guide future conservation practices for this species. BIOL 497 students are trained and then teach local high school students how to track turtles using advanced radiotelemetry techniques, collect spatial data with Global Positioning System (GPS) receivers, and input that data into a Geographic Information Systems (GIS) database. A third project involves monitoring survivorship of twenty acres of restored forested riparian habitat at Presquile Island National Wildlife Refuge, benefiting the U.S. Fish and Wildlife Service and the James River Association. BIOL 497 students collect data and help evaluate the success of this restoration effort. Finally, BIOL 497 students assist researchers from the Science Museum of Virginia with an ongoing baseline study modeling watershed aquatic biodiversity relative to climate change in Northern Virginia streams.

Other service activity opportunities for BIOL 497 students include invasive species removal and public education on wetlands for the James River Park System (a City of Richmond public park). Students educate the public on Virginia's aquatic habitats, participate in fish pathological studies, and provide guided physical therapy for aquatic

turtles at a local city park (Maymont Park). BIOL 497 students have participated in Virginia's first two Extreme Stream Makeovers sponsored by the James River Association to restore stream habitats. Alternative Spring Break, sponsored by the James River Association and the Chesapeake Bay Foundation, allows BIOL 497 and other VCU students to spend their spring break restoring wetlands within the Chesapeake Bay watershed.

Students participating in BIOL 497 have considered this a “transformative” course. They acquire valuable, relevant, marketable skills, such as proficiency with GPS/GIS technologies and monitoring protocols that are not necessarily available in their other coursework. Several undergraduate students who had originally not considered graduate work in the ecological sciences have been inspired to pursue advanced degrees in ecology and environmental sciences. BIOL 497 students have been recognized for their service activities by the Ocean Conservancy, Clean Virginia Waterways, and the VADCR, and have been interviewed by local news stations and newspapers for participation in community projects. One student has become the campus liaison for the Chesapeake Bay Foundation and coordinates activities with the VCU undergraduate student body. Many BIOL 497 students have continued to work on a voluntary basis for some of our local community partners; some have gained employment with these community partners and are actually training and overseeing our students' service-learning activities.

## **Model Outreach Program**

Universities are well-positioned to partner with K-12 educational institutions to provide the educational pipelines that will attract young people to study science, technology, engineering, and math (STEM) disciplines and to develop the skills and dispositions to enter the growing number of new green-collar jobs. *Jones and Ringo in Green-Collar Jobs in America's Cities: Building Pathways out of Poverty and Careers in the Clean Energy Economy* define green-collar jobs as “well paid, career track jobs that contribute directly to preserving or enhancing environmental quality” (2008). Service-learning pedagogy provides the real-world, hands-on learning experiences that provide teens with opportunities to make a real difference in their communities and to recognize the value and excitement of studying STEM disciplines and seeking careers in the growing green jobs market.

In 2009, VCU received external funding from Learn and Serve America and the Corporation for National and Community Service to develop and implement a continuing education program for science, technology, and math teachers from low-resource middle schools. The program, called GreenSTEM@VCU, assists these teachers in delivering service-learning lessons that engage 11- to 14-year-old students in green STEM content while meeting their community's needs in energy conservation, clean energy innovation, and green jobs exploration. The following section provides a description of this model outreach program, including the program structure, content, and goals.

## **GreenSTEM@VCU**

GreenSTEM@VCU involves a multidisciplinary team of VCU faculty members from the School of Engineering, Life Sciences Program, and Service-Learning Program Office. These experts will design an innovative weeklong summer academy for teachers that will be offered during the summers of 2010 and 2011 on the VCU campus. Through a competitive application process, teams of approximately 70 teachers (35 per summer) from public school divisions serving low-income middle-school students (50 percent or greater free and reduced lunch) in Virginia, the District of Columbia, and surrounding states will be selected to participate in the GreenSTEM@VCU Summer Academies.

The GreenSTEM@VCU Summer Academy is an intensive five-day learning experience for which VCU provides all accommodations and logistical support free of charge to participating teachers. The Academy is modeled after VCU's successful Summer Workshop Series (<http://www.community.vcu.edu/programs/sws/>). Participating teachers who successfully complete the Summer Academy earn three graduate-level college credits free of charge. During the Academy week, GreenSTEM@VCU expert instructors introduce teachers to alternative clean energy and energy conservation innovations and guide them in developing outlines for their own service-learning integrated STEM lesson plans that incorporate the *K-12 Service-Learning Standards for Quality Practice*, published by the National Youth Leadership Council. Teacher teams will work together throughout the week to learn service-learning pedagogy, to explore green jobs, and to outline their service-learning integrated STEM lessons.

For specific STEM training, teacher teams attend a multiday Sustainability workshop taught by VCU Life Sciences faculty members and a multiday Alternative Energy workshop taught by VCU School of Engineering faculty members. The Sustainability workshop introduces teachers to green architecture and environmentally friendly construction practices. Curricula focus on VCU's Rice Center education building (a platinum-LEED facility, <http://www.vcu.edu/rice/>) as a living system that incorporates ecological principles into its operation. For example, teachers examine the function of the Rice Center's green roof, calculating (and comparing to traditional roofs) runoff values, temperature modulation, and impacts on water quality. Teachers acquire the knowledge and practical skills necessary to engage students in real-world problem-solving while developing algebra and graphing skills. Teachers tour the wooded and marsh areas around the Rice Center, are introduced to VCU research projects, and have an opportunity to discuss green careers in environmental/life sciences with industry professionals.

The Alternative Energy workshop provides teachers with hands-on training in green engineering/technology and the opportunity to work with kits designed to improve their understanding of alternative energy sources. Topics include photovoltaics (solar cells), solar water heating systems, solar powered robots, and wind power. Workshops are presented at a level that enables teachers to implement similar learning activities in their own middle school classrooms. Practical applications of mathematics, such as

calculating the efficiency, power, and costs associated with solar and wind power compared to more conventional methods of generating electricity, are included to provide students with an understanding of skills needed for careers in clean energy sectors. Teachers tour the School of Engineering and are introduced to the six undergraduate majors offered at VCU as a way of broadening their understanding of engineering careers.

Participating teachers complete service-learning workshops to learn the components of high-quality service-learning instruction as these apply to the STEM disciplines, including how to (a) actively involve students of varying abilities in investigating community needs in the areas of energy conservation and alternative clean energy innovation, (b) develop students' ability to work collaboratively (with school- and community-based partners) to plan and implement a meaningful green service-learning project, (c) guide students' reflection on the process they used and on the links between STEM academic content and the green service-learning project, and (d) support students' efforts to share the results of their green service-learning project with a wide audience and celebrate their collective accomplishments.

The grant funding provides participating teachers with the opportunity to apply for \$5,000 mini-grants to support service-learning projects that address local green energy needs. Throughout the following school year, teachers receive online training and technical assistance from VCU experts and are able to interact with their Summer Academy classmates via Ning.com.

During the first two years of the project, Summer Academy instruction and some teachers' service-learning projects will be videotaped. During the third and final year of the funded project, a series of videos and lesson plans will be developed. These will be modeled after VCU's highly successful *Secrets of the Sequence* series for teachers (<http://www.pubinfo.vcu.edu/secretsofthesequence/>) and by 2014 these videos will be disseminated for free on the GreenSTEM@VCU webpage and on iTunesU. Once funding ends for this project, the GreenSTEM@VCU Summer Academy will continue to be offered as part of the VCU's Continuing Studies' Summer Workshop Series.

The impact of the GreenSTEM@VCU project is being evaluated in several ways. During the two Summer Academies, participating teachers provide formative and summative evaluation data, including but not limited to (1) pre/post-training questionnaires related to knowledge of high quality service-learning pedagogy, STEM-driven alternative clean energy innovations, and green job opportunities and (2) post-training satisfaction and acceptability surveys related to the curriculum structure/content. Service-learning projects/lessons developed by participating teachers will be evaluated to determine compliance with the *K-12 Standards for High Quality Service-Learning*, and the students who participate in service-learning projects/lessons will be assessed on knowledge and attitude changes on pre/post-lesson tests related to energy conservation, alternative clean energy innovations, green jobs, and the intention to stay in school. The project expects to influence more than 100,000 middle school students and to reach a worldwide audience through its online video lessons.

## Discussion

Green service-learning courses provide urban universities with an effective vehicle for developing students' environmental and ecological literacy and civic engagement ethic while positively influencing the ecological health of the urban environment in which they exist. Undergraduate students in VCU's green service-learning courses come from a wide variety of majors and disciplines, including religious studies, international studies, geography, education, history, mass communications, psychology, social work, pre-health and biology. Their service work has helped to create local urban community gardens, clear urban creeks, monitor habitats and threatened species, educate children and adults about current ecological issues, inform governmental policy, and provide role models for urban public school children. Faculty members who teach green service-learning courses at VCU have been successful in publishing their work in refereed professional journals and in attracting external funding to support their community-based research.

Importantly, these green service-learning initiatives have raised the visibility of VCU students and faculty within the local community and especially within local public schools, where the undergraduate students, in their black and gold VCU t-shirts, serve as role models for inner city youth and encourage these young people to care about their environment and to stay in school. The GreenSTEM@VCU outreach project provides direct training to teachers from low-resource middle schools to promote green service-learning lessons in their own schools and communities—lessons that inspire teens to graduate from high school and to enter postsecondary educational programs that teach green job skills.

VCU strives to provide learner-centered teaching that engages both faculty and students. By integrating Capra's "theory of living systems" with community-based projects, green service-learning courses enrich learning-centered teaching by connecting faculty, scholarship, students, and the world to create a dynamic learning environment. This ecological model of pedagogy supports deeper understanding of and appreciation for the factors that shape our relationship to the earth's ecosystems and promotes the integrated development of critical thinking, cultural understanding, ethical reasoning, and civic-leadership skills. The model enables students, faculty, and citizens to develop the intellectual and practical capacities to replenish and sustain these systems, that is, to "embody [ecological principles] in the daily life of human communities" (Capra 1999).

While all of these green service-learning initiatives foster students' ecological and environmental literacy, no single course can provide students with all of the knowledge required to comprehend the diverse forces that have shaped human-environment interaction or the capacity-building resources to reshape this relationship. The human-environment relationship is, after all, affected by the complex interactions between biology, technology, politics, economics, cultural values, and worldviews. For these reasons, we believe that a multidisciplinary certificate program or minor in ecoliteracy is a critical next step for VCU and for other urban universities. Such a program/minor

would integrate green service-learning courses such as those we have described here with additional coursework and community-based learning experiences in related disciplines such as government and public policy, urban planning, business and engineering. We believe such a program would be popular with students and would equip them with a broad range of skills that would enable them to succeed in employment, graduate-level study, and civic leadership.

The critical role played by Service-Learning Program Offices in the implementation of successful, high quality green service-learning courses cannot be overstated. These offices should be staffed with professionals who are experts in higher education pedagogy, who understand tenure and promotion policies, and who possess a deep and broad working knowledge of and relationships within the local community. Service-Learning Program Office staff members can provide faculty members with the support they need to link community-based service projects to the learning objectives of the course, to develop reflection activities that promote students' integration of learning, and to identify community organizations with which faculty members can establish mutually beneficial partnerships. These professionals can also work across disciplines to introduce faculty members with similar community-based research and teaching interests to each other. Service-Learning Program Office staff members also play a critical role in facilitating collaborations amongst service-learning instructors, their students and community partners to support external research funding and writing projects (e.g., books and refereed journal articles). These staff members also provide data to support university reports that describe community impact initiatives and work closely with student affairs and media relations staff, alumni associations, and advancement officers at their universities.

## **Conclusion**

The need for an ecoliterate global citizenry has never been greater or more urgent, and urban universities are well positioned to lead in the development of this citizenry. Green service-learning courses, such as the ones we have described in this paper, provide an excellent first step in this process. We agree with Fritjof Capra, cofounder of the Center for Ecoliteracy ([www.ecoliteracy.org](http://www.ecoliteracy.org)), when he states, "Teaching this ecological knowledge will be the most important role of education in the next century." At VCU, we look forward to fulfilling this role by offering a curriculum that empowers students to live as ecologically engaged citizens.

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