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The ESA21 Project: A Model for Civic Engagement

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By John Pratte and Matt Laposata

Making the content of a course interesting to students can be quite a challenge for an instructor. Making the content of a required general education science course interesting to non-science majors can be near to impossible. A lack of interest in a subject is not to be underestimated as a detriment to learning. Even the brightest student will be reduced to rote memorization and doing the bare minimum in a class that does not provide some spark of interest.

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There have been many systematic approaches to solving this problem proposed over time. One that is currently receiving interest in the sciences is the use civic engagement within the classroom ("Highlights from AAC&U Work on Civic Engagement" 2003, Lucey 2002). This interdisciplinary approach infuses current societal issues into the course content in such a way that students not only see a connection between the course and their civic life, but also begin to use the course to seek solutions to civic problems. The ultimate goal is to teach students how to be better citizens of this country and planet. A good example of this approach is a service learning course that has students working with community groups on a problem (Haines 2003, Farnsworth, et.al. 2001, Shachter and Edgerly 1999). This approach works well in small enrollment courses, but it is logistically difficult to implement in large enrollment courses. Large enrollment classes lend themselves more naturally to other civic engagement approaches, such as special topics courses with individual or group research projects (Burns 2002, Fluck 2001).

We choose to meld the two approaches, thus creating a collection of activity modules for environmental science courses that use a personalized civic engagement model. In this way each student looks at their individual impact on society and the environment and researches how they can change it.

Activity design

The activity modules we have created seek to engage students on issues vital to the public (climate change, energy, ground-level ozone, etc.). This is done over a period of several weeks for each issue through a combination of hands-on, field, and Internet-based activities. Some of the activities provide background information on the issue, while others have the student research information about themselves and their lifestyle. At the conclusion of each module, students calculate just how much they impact their environment or the environment impacts them during the course of their normal day. They then investigate ways that they can change this impact by making changes in their lifestyle. Figure 1 contains a short description of the activities in the modules that have been used and assessed in the lab portion of an environmental science course.

The major goal of these activities is to give our students a better learning experience than standard labs while increasing their interest in the materials. These modules stand in contrast to the standard labs for an environmental science class that present different topics from week to week and allow for little in-depth study. The hybridization of online, field, and wet-lab exercises allows us to take advantage of the best resources available for learning and civic engagement, such as governmental databases, online calculators, simulations, and virtual fieldtrips. The uses of these materials also helps to reduce development costs by utilizing existing, high-quality materials from the Internet, with considerations given to "stabilize" these resources (to prevent the occurrence of linked websites going down for lengthy periods of time, we now require that key websites be mirrored on our site). The activities place a great deal of emphasis on lifestyle examination, ethical considerations, and critical analysis of individual contributions to large-scale regional and global impacts. This approach addresses the weakness of traditional environmental science exercises and provided students with a relevant, related set of activities that tie closely with their everyday lives.

A review of the home energy module gives an example of how these modules work. In the first week of the

FIGURE 1. Modules and activities developed for the project.

Module	Activity	Description
Basic skills and principles	Experimental analysis	Use software program Fish Farm to design and conduct simulated experiments in aquaculture.
	Statistics and graphing	Use descriptive statistics and graphing to analyze experimental data..
	Measurement	Gain experience with measurements and use inferential statistics to interpret experimental data.
	Capstone	Create hypothesis, gather data by measurement, and evaluate results using descriptive and inferential statistics. Critique elements of experimental design.
Energy	Home energy audit	Measure dimensions and identify materials of exterior components of home.
	R-factor	Measure R-factor of typical materials used in home construction.
	Synthesis and analysis	Analyze home energy usage using data gathered in first activity.
	Capstone	Propose and economically evaluate three improvements to home energy efficiency.
Biogeochemical cycling	Trees and carbon	Estimate the amount of carbon sequestered in trees using measurements of tree diameters.
	Carbon cycling	Examine the processes of photosynthesis and respiration and their effects on carbon cycling in wet-lab exercises.
	Analysis of personal impacts	Estimate the amount of carbon dioxide released by student's lifestyle, and evaluate reasonable changes that would reduce emissions.
	Capstone	Determine acres of forest needed to sequester individual outputs and evaluate the efficacy of "carbon credits" programs.
Ozone	Ground-level ozone	Use computer simulation to investigate the parameters that affect ground-level ozone levels and evaluate competing scenarios in regards to air quality.
	Stratospheric ozone	Measure the relationship between stratospheric ozone level and the ultraviolet light index.
	Analysis of personal impacts	Estimate the amount of ozone precursors released by various vehicles. Evaluate the ethics of driving a vehicle with low MPG by examining pollutant effects on the human respiratory system.
	Capstone	Estimate the amount of ozone precursors released by student's lifestyle and evaluate reasonable changes that would reduce emissions.

module, students measure and ascertain various parameters about their home, such as how much floor space and ceiling are in contact with the outside and of what material the walls are made. The second week of the module is spent investigating the relationship between the R-factor of various home building materials and the rate at which heat is conducted via a hands-on experiment in the lab. In the final week, the information gathered in the first week of the module is used to perform a home energy audit to see how much energy the student is responsible for using. As a capstone activity, students investigate three different changes, such as adding insulation or changing windows, that they could make to their home to lower their energy usage and rate them according to their economic viability.

The laboratory course in which these four modules have been used is the general education science course required of all non-science majors, which typically enrolls over 1,700 students per semester. Because so many different faculty, who all teach with different styles and speed, oversee this course during a given semester, one important facet of the modules is that they are textbook and instructor independent. This is achieved by providing introductory and background information on the topics via such sources as government pamphlets and audio/video clips.

While the project collection does offer alternatives that allow the modules to be done completely online, we have chosen to use some hands-on laboratory activities in the modules via an "open-lab" format. During the weeks that the hands-on activities are being done, students can choose, either individually or in small groups, to visit the lab to complete the activity. The lab is staffed by faculty and student assistants to assist students with problems both on the particular activity and the module in general. Course instructors also spend time in the classroom introducing and demonstrating the activities. Student performance of the modules is determined by the individual instructor, who can choose from grading lab reports, grading activity sheets, and/or quizzing. Surveys of students during the course of the last several years have shown that this mixture of hands-on, Internet, and field-based activities is the preferred method of lab delivery, with a large fraction of students designating the ability to receive help from instructors in the lab and the meaningfulness of the labs as vital to their success.

Evaluation of the labs

Different aspects of the lab and the course have been assessed over the years using a variety of instruments. Of importance to this article are the assessments that concern the engagement of the students and the effect that the labs have had on the students' interests, learning, and lifestyles. These were done using the Student Assessment of Learning Gains instrument sponsored by SENCER (Heady 2001, SALG website). This instrument is given as a pre- and post- class survey that tracks individual student responses using the SALG website at the University of Wisconsin. It measures student interest in science and civic matters, as well as student perceptions of the degree of learning facilitated by the various aspects of the course. The instrument is standardized by the SENCER program, but allows the individual instructor to add questions to the survey.

Figure 2 shows a comparison between data from surveys that were taken both before and after the lab modules were instituted in the course. The survey was originally given to 140 students in the spring of 2001 who were still using the standard environmental science labs that had a different topic each week. It was also given to 68 students in the spring of 2004 after the full development of the module activity set. The results show that there was a significant increase in the students' perception of the value of the lab activities to themselves and to their understanding of the course material. Of equal importance, the modules increased their awareness that they have a part in solving environmental problems and caused them to change their lifestyles to do so.

Figure 3 shows the importance of different aspects of the class to student learning for the students who used the activity modules. Almost 80 percent of the students reported that the focus on real world issues was of much or very much help to them, while almost 60 percent stated the same for the focus on science and civic issues. The students were also presented with an open-ended

FIGURE 2. Student opinions about the relevance of the course.

Question	Answers	Spring 2001	Spring 2004
The laboratory exercises were about issues that affect me	Agree Neutral Disagree	26 percent 36 percent 37 percent	78 percent 13 percent 7 percent
The laboratory program helped me to understand environmental issues	Agree Neutral Disagree	50 percent 30 percent 20 percent	79 percent 12 percent 5 percent
The laboratory program made me realize that I have a part in solving environmental problems	Agree Neutral Disagree	43 percent 29 percent 28 percent	78 percent 13 percent 7 percent
Participating in this laboratory program caused me to change the way I do some things	Agree Neutral Disagree	17 percent 31 percent 52 percent	59 percent 22 percent 16 percent

FIGURE 3. Post course question about effect on learning of different course factors.

How much did each of the following help your learning? (68 Responses)

Item	1=No help	2=A little help	3=Moderate help	4=Much help	5=Very much help	NA	Mean
Focus on addressing real-world issues	0 percent	6 percent	16 percent	54 percent	24 percent	0 percent	3.96
Focus on interplay between science and civic issues	3 percent	10 percent	26 percent	49 percent	10 percent	1 percent	3.54
Learning how real science is done	0 percent	10 percent	34 percent	49 percent	7 percent	0 percent	3.53
Lab activities	4 percent	12 percent	34 percent	37 percent	12 percent	1 percent	3.40
Gathering scientific data in labs or in the field	3 percent	16 percent	31 percent	38 percent	9 percent	1 percent	3.35
Analyzing scientific data	1 percent	13 percent	47 percent	32 percent	4 percent	1 percent	3.25
Studying course text	16 percent	22 percent	31 percent	22 percent	6 percent	0 percent	2.79

question that asked them to clarify exactly which aspect helped them the most. Almost half of the students mentioned something dealing with the lab, such as "The labs helped connect the content of the course to real-world situations. It was especially meaningful to measure my personal impact through several of the labs" and "Doing the labs helped me learn a lot about the environment especially the ones on smog and pollution." This data reinforces the results from Figure 2 that the emphasis on lab activities related to civic engagement has helped student learning a great deal.

Figure 4 shows the number of responses that indicated a decrease, increase, or no change in the interests of the students to various activities over the course of the class. Using a five-point Likert scale (from Not At All Interested=1 to Extremely Interested=5) to score the responses, we were able to measure the difference in each student's response from the pre- to the post-survey, and then calculate the average change in student responses. The table shows that the average in the differences increased for each activity. While some of the increases are modest, others, such as discussing science and taking another science course, increased by almost half a category designation. Again, this reinforces the evidence that the labs have increased the student's interest in civic engagement and science in general.

Lastly, Figure 5 shows the student responses to a statement about which activities they are likely to do after having completed the course. This data shows that student interest increased for activities like recycling, driving a fuel efficient car, and repairing their home that are directly addressed by the laboratory modules. It also increased for other civic activities, such as voting in elections and discussing civic issues informally, that were not directly addressed by the modules, but that require a low amount of involvement in groups and time. However, interest in other civic activities, such as doing an internship in a civic organization or writing a public official, actually decreased over the

FIGURE 4. Change in student interest in activities from the beginning to the end of course.
(number of students in each category and average Likert score difference)

After finishing this class, I am interested in... (56 responses total)

Item	Interest decrease	No change	Interest increase	Mean difference
Discussing science with friends or family	8	20	28	.46
Reading about science and its relation to civic issues	12	24	20	.20
Reading articles about science in magazines, journals or on the internet	10	20	26	.29
Taking additional science courses after this one	12	18	26	.46
Majoring in a science-related field	6	30	17	.25
Exploring career opportunities in science	8	29	16	.19
Joining a science club or organization	6	34	15	.29
Attending graduate school in a science-related field	5	35	11	.18
Teaching science	2	38	12	.29

FIGURE 5. Post course question about likelihood of doing activity.

After finishing this class, I am more likely to... (68 Responses)

Item	1=Strongly disagree	2=Disagree	3=Neutral	4=Agree	5=Strongly agree	NA	Mean
Vote in elections	3 percent	1 percent	16 percent	35 percent	43 percent	1 percent	4.15
Actively recycle waste products in my house	1 percent	6 percent	18 percent	47 percent	28 percent	0 percent	3.94
Buy a more efficient home or repair the one I have to make it more efficient	3 percent	7 percent	25 percent	41 percent	19 percent	4 percent	3.69
Discuss a civic or political issue informally	6 percent	4 percent	24 percent	56 percent	10 percent	0 percent	3.6
Buy a more efficient vehicle	6 percent	7 percent	24 percent	47 percent	15 percent	1 percent	3.58
Discuss a science-related issue informally	7 percent	7 percent	28 percent	49 percent	9 percent	0 percent	3.44
Read a science-related magazine	6 percent	21 percent	24 percent	41 percent	6 percent	0 percent	3.21
Talk with a public official about a civic or science-related issue	10 percent	24 percent	41 percent	21 percent	3 percent	1 percent	2.82
Write a letter or email a public official about a science-related issue	9 percent	34 percent	44 percent	7 percent	4 percent	1 percent	2.64
Do an internship at a civic organization	21 percent	34 percent	28 percent	13 percent	3 percent	1 percent	2.43

course of class. This is not surprising, as the labs offered no encouragement or information toward doing these things, and these activities require much more time and involvement.

Summary

The activity modules used in the lab have increased student interest in the course content and in using their knowledge in extracurricular activities. The students report that focusing the course on civic engagement helps them to learn the material. Work is continuing on performing similar assessments on the other activity modules in the ESA21 project. All of these activities are available through the project website, and we invite instructors to utilize them and provide feedback.

Acknowledgement

The activities included in the modules have been used and assessed in the lab portion of the environmental science course at Kennesaw State University (KSU). These four modules are just part of the twelve in the Environmental Science Activities for the 21st Century Project (an NSF-funded consortium of Bowling Green State University, Community College of Baltimore County, Kennesaw State, and the University of Southern Mississippi). For a better description of all of the modules, please visit the website *esa21.kennesaw.edu*.

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