EXPERIENTIAL LEARNING AND THE SENCER APPROACH

Applying the Science of Learning to the Learning of Science (and More)
What’s it like to be a student today?

The State of Earth

- Climate change
- Mass extinctions
- Exponential human population growth
- Poverty/hunger
- Peak oil
- The water crisis

Is constant economic growth possible in a closed, finite system?

http://political-freedom.webs.com/climatechange.htm
What is Sustainability?

• Providing for our present needs while not hindering the ability of future generations to do the same.

http://maggiegoesgreen.blogspot.com/2010/02/what-is-sustainability.html
The “three E’s” of Sustainability

Environment

True Sustainability

Equity

Economy
Assessing Effectiveness of Pedagogical Techniques Used in Environmental Education: Content Acquisition and Attitude Shifts in an Experiment with Pine Rocklands in the Ecology of South Florida Lab

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Research Questions/Hypotheses

• Do experiential pedagogical approaches offer advantages over traditional teaching in increasing environmental knowledge (content acquisition)?

• Are experiential pedagogical approaches more effective for some demographic categories than others?

• Do experiential pedagogical approaches offer advantages in fostering ecocentric attitudes?
The Ecology of South Florida class and lab offer a unique opportunity for undergraduates to learn about and experience first hand South Florida’s distinctive natural areas.
This rare pineland is found only in South Florida and the Bahamas.

Only about 17,348 acres are left, mostly inside Everglades National Park.
Prior to development, there were about 185,000 acres of pine rockland in Miami-Dade County. Today, only about 4,000 acres of pine rockland remain outside of Everglades National Park.

"Pine Rocklands Born from Fire," a Miami-Dade County publication.
Methodology

- The 13 sections of the lab were divided into four treatment groups
  - Control
  - Deep Ecology
  - Issue Investigation
  - Service Learning
Deep Ecology

• The “Mirror Walk”: a sensory experience designed to deepen connection to the natural world.
  • With their eyes closed, students were led by a partner who would indicate when to touch, smell or open eyes and look.
Reflection:
Deep Ecology Art Projects
Issue Investigation
Public Awareness Projects

BE FIREWISE!

Do you know if you live in the Pine Rocklands?
Many developments have occurred in the very
Pine Rocklands causing the ecosystem to be highly
deteriorated. It's important to maintain what's
left. Fires are one of the most helpful ways of
maintaining these systems.

A prescribed fire ignited by range in the
Pine Rocklands.

New palmetto growing in the Pine
Rocklands after a Prescribed Burn.

History of the Problem
The Pine Rockland community
canopy is dominated almost
exclusively by Slash Pine. A sub
climatic community, pine rock lands
have depended on wildfire to keep
them from transitioning into
hardwood hammocks. One of the
problems the pine rock lands have is
that it is home to many endangered
species, including the Red-cockaded
Woodpecker.

The Red-cockaded Woodpecker
(Picoides borealis)
Approximately 8.5 in (20-21 cm)
long
Weight of about 1.5 ounces
Wingspan of about 14 in (36 cm)

Causes of the Problem
The main reason the red-cockaded
woodpecker is on the list of
endangered species is because of
habitat loss. Habitat loss is occurring
because of clear cutting for
agriculture and logging. This is a
problem because loss of trees means
fewer trees suitable for excavating.
They love doing that. That also means
fewer trees available where they can
find food.
Service Learning
Assessment

• Pre- and post-tests were administered measuring content acquisition
• Pre and post-surveys were conducted, collecting data on attitudes and perceptions
• Demographic data were collected
• A small, random sample of students were selected for interviews
<table>
<thead>
<tr>
<th>Type of data</th>
<th>Data collection instrument</th>
<th>Scoring/coding</th>
<th>Administration</th>
</tr>
</thead>
<tbody>
<tr>
<td>Demographic</td>
<td>Self-report</td>
<td>Count</td>
<td>Pre</td>
</tr>
<tr>
<td>Knowledge of Pine Rocklands</td>
<td>Multiple choice test</td>
<td>Percentage correct</td>
<td>Pre-Post</td>
</tr>
<tr>
<td>Attitude and perceptions toward environment</td>
<td>Likert scale</td>
<td></td>
<td>Post</td>
</tr>
<tr>
<td></td>
<td>Essays on environmental ethical orientation and Likert-scale comparison</td>
<td>Coded for anthropocentric, neutral or ecocentric</td>
<td>Pre-Post</td>
</tr>
<tr>
<td>Ethical orientation</td>
<td>Essay questions</td>
<td></td>
<td>Post</td>
</tr>
<tr>
<td>Opinion of educational technique</td>
<td>Interview with eight students</td>
<td>Categorized statements</td>
<td>Post</td>
</tr>
<tr>
<td>Thoughts and attitudes toward teaching</td>
<td></td>
<td></td>
<td>Post</td>
</tr>
</tbody>
</table>
Results...
HYPOTHESIS ONE:

Progressive pedagogical approaches offer advantages over traditional education techniques in increasing environmental knowledge.
Pre-test/Post-test Comparison

- ANOVA shows a nearly significant difference among treatment groups, $F(3, 145) = 2.14, p = .098$

- Post-hoc shows a significant difference between Deep Ecology and Control ($p = 0.043$) and Deep Ecology and Service Learning ($p = 0.025$).
Conclusion:

• The data fail to support the hypothesis at $\alpha = 0.05$, but still suggest that some progressive teaching techniques (Deep Ecology and Issue Investigation) offer advantages over traditional teaching techniques (Control) in increasing environmental knowledge.
Hypothesis Two:

- Experiential pedagogical approaches are more effective for some demographic categories than for others.
Tests of between-subjects effects shows a significantly higher mean in difference scores, $F(1, 120) = 4.06$, $p = 0.046$, for Hispanics (26.16) compared to non-Hispanic (18.15).
Looking at the overall means of difference in test scores, Hispanics showed greater content acquisition in all treatment groups.
When comparing scores by gender, females showed a greater gain. Tests of between-subject effects shows this to be only marginally significant ($< p = 0.10$) at $F (1,122) = 3.48$, $p = 0.065$. 

Letters indicate significant differences at $\alpha = .05$. 

$p = 0.030$

$p = 0.065$
Conclusion:

• The data support the hypothesis that some progressive teaching techniques are more effective for some demographic categories (but not all) at $\alpha = 0.05$. 
Hypothesis Three:

- Some progressive pedagogical approaches offer advantages over others in fostering ecocentric attitudes.
Pre- and post-test ethical orientation by treatment.

Figure 8a. Pre-Test Orientations

Figure 8b. Post-Test Orientations
Wilcoxon Signed Ranks Test found a significant change in Issue Investigation with 47.1% of the group more ecocentric, and a notable, though not statistically significant change in orientation in Deep Ecology with 33% of the group more ecocentric.

<table>
<thead>
<tr>
<th>Treatment</th>
<th>P-Value</th>
</tr>
</thead>
<tbody>
<tr>
<td>Control</td>
<td>.980</td>
</tr>
<tr>
<td>Deep Ecology</td>
<td>.087</td>
</tr>
<tr>
<td>Issue Investigation</td>
<td>.008</td>
</tr>
<tr>
<td>Service Learning</td>
<td>.186</td>
</tr>
</tbody>
</table>
Conclusion:

• The data provisionally support the hypothesis that some progressive teaching techniques are more effective at fostering ecocentric attitudes than others at $\alpha = 0.05$. 
Significance of This Study
Effectiveness

- This study shows the effectiveness of experiential, place-based education
- Content Acquisition
- Fosters ecocentric attitudes that could send students down the path to environmental literacy.
Statistical Significance

• Not all of the trends were statistically significant at $\alpha = 0.05$
  
  • Most were close enough that they might be considered “marginally significant” ($< p = 0.10$)
  
  • Post-hoc tests showed statistical significance
  
  • Deep Ecology and Service Learning
  
  • Larger samples sizes may have given significant results.

• More work is indicated.
Conclusion

• Active engagement of students using experiential, place-based learning can enhance content acquisition as well as modify environmental attitudes.

• The more we are engaged with the world, the more we care, and this can only improve our relationship with nature.
What is experiential learning?

http://lccc.wy.edu/academics/serviceLearning
Experiential Learning

- Learning by doing
- Dates back to 1800s and the progressive educators:
  - John Dewey, nature study movement, Louis Agassiz, Liberty Hyde Bailey, Anna Botsford Comstock, Wilbur Jackson
We gather information through our senses

- Activities such as grasping, moving, counting, and manipulation aid in the learning process.

http://www.buzzle.com/articles/how-many-senses-does-a-human-have.html
The Dilemma

• In elementary education, learning by doing is more common
  • Field investigations
• But secondary education students are expected to learn from books
  • Secondary students find school less meaningful and relevant (2002, US Dept. of Education)
Benefits of Experiential Learning

• By giving older youth an opportunity to explore community issues and develop plans for action, schools are realizing important benefits of experiential learning

Reflection

- Experiential education is not just “doing”, there must be critical reflection.
  - Mental effort of comprehending what the experience entailed, connecting prior knowledge to new information, accommodating new information into the mental model
  - Brain researchers call this “re-activation of the memory.”

http://www.ifad.org/evaluation/guide/8/
Experiential Learning Cycle

• Different versions, but all have **two things in common**:

  1. An experience/active endeavor
  2. Thoughtful, reflective analysis of that experience
Four-Step Version

1. The experience

2. Processing
   • What happened? What was observed? What data was collected?

3. Generalizing
   • Forming hypotheses about such questions as why was one group’s experience different from another?

4. Apply the knowledge
   • Based on what was just learned, what would happen in another situation?
A five-step learning cycle developed by Bob Karplus at UC-Berkely (5 E’s):

1. **Engage**: learners are introduced to the task and make connections to things they already know. Motivating questions and problems are often used to spark curiosity and discussion.

2. **Explore**: learners are directly involved in activities, field observations, data manipulation, etc. Questions and interaction with others help them guild concepts about the new information.

3. **Explain**: an instructor provides information about the concepts through lecture, readings, and discussion. Abstract concepts are introduced and explained.

4. **Elaborate**: learners apply these concepts in a new situation, testing patterns and ideas and verifying their understanding.

5. **Evaluate**: instructors employ assessment techniques to monitor and quantify learners’ progress.
Reflection Tools

- Worksheets, journals, and other tools may be used to guide learners through this process.
- Think “outside of the box”—art in a science classroom, for example.
- Take advantage of digital media: blogs, social media, websites, videos, etc.
Different Types of Learning...

- These learning cycles tie-in with Bloom’s Taxonomy, guiding learners from lower-level to higher-level learning.
The Bottom Line...

• Studies have shown that learning occurs when students are engaged in an experience, have an opportunity to reflect on it, and use the information to build new ideas.

• The specifics of which model and how many steps are not important.
Civic Engagement

• "Our ways of handling power differences and diverse points of view and cultures should be models of the civic life we wish to engender in our communities. Encouraging the articulation of differences, and then finding areas for collaboration, should be the norm rather than the exception."

--Gamson, Z.F.

*Civic Responsibility and Higher Education*, 2000
The Definition of Civic Engagement

• “Civic engagement means working to make a difference in the civic life of our communities and developing the combination of knowledge, skills, values and motivation to make that difference. It means promoting the quality of life in a community, through both political and non-political processes.”

The Definition of Civic Engagement (cont.)

• “A morally and civically responsible individual recognizes himself or herself as a member of a larger social fabric and therefore considers social problems to be at least partly his or her own; such an individual is willing to see the moral and civic dimensions of issues, to make and justify informed moral and civic judgments, and to take action when appropriate.”

SENCER courses and programs strengthen student learning and interest in the sciences, technology, engineering, and mathematics by connecting course topics to issues of critical local, national, and global importance.

www.SENCER.net
What is SENCER?

• SENCER applies the science of learning to the learning of science, all to expand civic capacity.
  • Scholarship of Teaching and Learning

• SENCER courses and programs connect science, technology, engineering, and mathematics content to critical local, national, and global challenges.

• Students and faculty report that the SENCER approach makes science more real, accessible, "useful" and civically important.
Background

- Initiated in 2001 under the National Science Foundation’s CCLI (Course Curriculum and Laboratory Improvement) national dissemination track.

- SENCER has established and supported an ever-growing community of faculty, students, academic leaders, and others to improve undergraduate STEM education by connecting learning to critical civic questions.

- SENCER's particular origins can be found in a course developed at Rutgers University that focused curricular resources on the HIV epidemic.
  - Using the HIV epidemic to teach biological concepts increased student learning and connected this to critical civic questions.
SENCER Partners

• The SENCER community of practice includes more than 2,000 educators, administrators, and students from more than 430 two- and four-year colleges and universities, educational associations, government agencies, and non-governmental organizations in 46 states and 11 foreign nations.

• This community gathers in person at national workshops and symposia, regional events, professional association meetings, and online.
SENCER Ideals

- SENCER...
  - robustly connects science and civic engagement by teaching “through” complex, contested, capacious, current, and unresolved public issues “to” basic science.
  - invites students to put scientific knowledge and scientific method to immediate use on matters of immediate interest to students.
  - helps reveal the limits of science by identifying the elements of public issues where science doesn’t help us decide what to do.
  - shows the power of science by identifying the dimensions of a public issue that can be better understood with certain mathematical and scientific ways of knowing.
SENCER Ideals (cont.)

• SENCER...

  • conceives the intellectual project as practical and engaged from the start
    • as opposed to science education models that view the mind as a kind of “storage
      shed” where abstract knowledge may be secreted for vague potential uses.
  
  • seeks to extract from the immediate issues the larger, common lessons
    about scientific processes and methods.
  
  • Places the responsibilities (the burdens and the pleasures) of discovery on
    the student.
  
  • by focusing on contested issues, encourages student engagement with
    “multidisciplinary trouble” and with civic questions that require attention
    now.
  
  • in doing so, SENCER hopes to help students overcome both unfounded fears
    and unquestioning awe of science.
What SENCER Offers…

• Promotes work that increases the STEM knowledge base and broadens the impact of campus work.

• Supports a community of practice by offering faculty development programs through regional symposia and their annual Summer Institutes.
  • and supplements those interactions with a collection of resources, including field-tested featured and emerging course models, back grounder papers, and bi-weekly eNews updates.

• Encourages and participates in the development of assessment strategies and tools that help educators better evaluate and promote student learning and engagement (SALG).

• Supports advanced research in these areas.
Evaluation of SENCER

With support from the National Science Foundation, SENCER contracted with the University of Colorado, Boulder, for a multi-year, independent program evaluation. The results...

- Students gained most in the areas of science literacy, followed by general course skills.
- Women gained more than men and non-science majors gained more than science majors on many of the items and composite variables.
- The patterns of gains were in line with efforts by SENCER to encourage awareness of the link between civic issues and scientific content.
• Roughly a fifth of students who had never engaged in civic activities said they were more likely to participate in these activities after a SENCER course completion.
• Ten percent of students who, on the pre-survey, were not interested in taking additional science or mathematics courses, reported on the post-survey that there were very or extremely interested in doing so.
• Similarly, slightly more than 6% percent now say they would like to consider exploring career opportunities in science and nearly 5% are now "interested in teaching science."
The SENCER-SALG

- The SENCER Student Assessment of Learning Gains (SALG) allows students to rate how much specific activities in SENCER courses help their learning.
  - Asks students to report on their science skills and interests, as well as the civic activities in which they engage.
- Provides useful, formative feedback to faculty interested in improving their teaching.
- Students rate how much class activities such as lectures, discussions, or labs help their learning.
- Provides a snapshot of student skills and attitudes at the beginning and end of courses
  - allowing instructors to gauge the effectiveness of their instruction in specific areas.
- Also informs the national assessment of the SENCER program.
The SENCER-SALG (cont.)

• The SALG is unlike the traditional Faculty Course Questionnaire in that it does not ask students to rate the competencies of their instructors.

• In the spring of 2008, a new, updated SALG platform was launched
  • The result of efforts by a team supported by the National Science Foundation.
  • Many improvements to ease use and to take advantage of the latest research on teaching and learning.
The SENCER-SALG Format

• Basic format of 10 question-stems:
  • 6 related to course design and practices, and 4 related to course learning objectives.

• To ensure the conceptual identity of the SALG, these 10 question-stems can not be changed or deleted, nor can their answer-scales be altered.

• Within these limits, however, you may add to, delete or change any of the sub-questions under these stems to adapt your SALG to the specific design and goals of your course.
SALG Site

• http://salgsite.org/
SENCER Model Classes

• [http://www.sencer.net/Resources/models.cfm](http://www.sencer.net/Resources/models.cfm)

• Examples of how SENCER has been integrated into various curricula.