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Teaching of Biology: Including ELSI Activities in the Introductory Biology Classroom

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Abstract for DBER Group Discussion on 2013-04-11

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Title:
Teaching of Biology: Including ELSI Activities in the Introductory Biology Classroom

Abstract:
The increasing need for public input about ethical, legal, and social issues (ELSI) associated with science and technology implies a corresponding need for ethical education of students in the sciences. The changing goals of college biology courses further reflect growing awareness of such needs. What are the challenges associated with engaging science students—who may expect to focus only on “science” and not “ethics” issues—in such overarching discussions? In this presentation, we will discuss our design, implementation, and study of the use of ELSI deliberative activities in an introductory freshman-level biology course across five semesters. First, we will describe the activities and their goals. Second, we will present results evidencing the impacts of these activities on, for example, student engagement, learning, and evidence for critical thinking about applications of science in society. Finally, we will discuss the challenges and lessons learned from including such activities in the curriculum based on our research and evaluation activities.
Teaching of Biology:
Including ELSI* activities in the Introductory Biology Classroom

T. Jack Morris, Department of Biological Sciences, University of Nebraska-Lincoln
Lisa M. PytlikZillig, The Public Policy Center, University of Nebraska

DBER Group Presentation – April 2013

*ELSI – Ethical, Legal and Social Issues
Thank you

SciSIP Team Members

- Hina Acharya
- Ryan Anderson
- Tim Collins
- Jaime Detour
- Yuris Dzenis (Nanoscientist)
- Frank Gonzalez
- Becky Harris
- Myiah Hutchens (PI)
- Peter Muhlberger (former-PI)
- Jayme Neiman
- Brock Nelsen
- Peibei Sun
- Alan Tomkins (PI)
- Joe Turner (Nanoscientist)
- Shiyuan Wang

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- John Osterman
- Peter Angeletti

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• **Primary goal** - develop and test a social-cognitive model of public engagement to address science policy in the area of nanotechnology.

• **Central Hypothesis** - Variations in social contexts and cognitive purposes of public engagements will change individual and group-level mediating processes, resulting in different impacts on individual, scientific, and policy outcomes commonly used to evaluate the effectiveness of engagement efforts.

• **Educational impact** – Integration into an introductory biology course provided the opportunity to sensitize hundreds of science students of the need to inform the public about science, to have them discover how this might be done, to show how their science information and growth might be applied in a novel and interesting way, to have them gain experience in hypothesis testing, data collection, and evaluation.
Vision & Change in Undergraduate Biology Education (AAAS 2009) – toward meeting some of the goals of this ambitious national challenge to improve biology education

“A revolution is underway in biology. The major focus of the biological sciences—understanding life—remains the same, but the science has experienced a major transformation. Many of the most exciting discoveries in the biological sciences during the second half of the 20th century occurred at the intersections of established disciplines.... These new integrated fields, spread across the diversity of life sciences, are opening up a vast array of practical applications, ranging from new medical approaches, to alternative sources of energy, to new theoretical bases in the behavioral and social sciences.”

Why ELSI? Why Nanobiology?
The Activities
ELSI Engagement Learning Experiences for Students
Activities Overview

- **Assignment 1: Reflection (Hwk)**
- **Introductory Lecture** (large group)
- **TED video** (recitation)

- **Assignment 2: Reading (Hwk)**
  - Critical thinking prompts/training
  - Organization of information (notetaking)
  - Control group (explore)

- **Assignment 3: ELSI scenarios (Reci)**
  - Individual
  - Group (moderated/not; hetero/homo)

- **Assignment 4: Input (Hwk)**
Students were asked to reflect on their beginning knowledge of and attitudes toward nanotechnology.

Many reflected that they knew very little.
Students then had a guest lecturer who discussed ethical, legal, and social implications (ELSI) in a broad sense.

They also watched a 10-15 min video in recitation (e.g., “The genomic revolution”)

These activities were designed to inspire interest and relevance.
A background document was provided to the students that explained nanotechnology and its applications.

Students were in different conditions; e.g., asking them to take notes or prompting critical thinking.

The goal was to provide a knowledge base.

Assignment 2: Reading
Assignment 3: ELSI Scenarios

SCENARIO 1: “Assume that scientists have developed a way to improve human memory. This discovery has the potential to cure Alzheimer’s. It may also enable some people to develop super-human memory. Under what circumstances, if any, should this technology be restricted?”

SCENARIO 2: “Now assume that, sometime in the future, Mr. and Mrs. Vanderbilt decide they would like to have a baby. Both parents have the genetic markers for Cystic Fibrosis. Their doctor informs them that for $250,000 he can, through the use of nanogenetics, ensure that their baby is born without Cystic Fibrosis. The VanDerbists can afford this, but can’t agree on whether they should. Mrs. Vanderbilt favors any kind of intervention that may keep their future children healthy. ‘Protecting our children from suffering is a moral obligation,’ she argues. Mr. Vanderbilt, however, opposes any technology that can manipulate human genetics. He worries that while this technology might help his child, it will eventually be misused so that parents can engineer their children for superficial reasons. What do you think about this scenario? How should the law treat this technology?”

Please use all of your discussion time. Do not continue to the final question until your TA given you permission. If you are having trouble finding things to discuss and debate, consider these:

**BRAINSTORMING QUESTIONS**

- What would someone who disagrees with me say?
- What are some of the pros and cons of this technology?
- What are some potential second-order effects of this technology?
- What if I were personally involved in these issues? How might my perspective change?
- Are there any trade-offs we need to consider? If we do [insert suggestion from the group here], will that prevent us from doing something else that we might consider desirable later on?

- Usually, half the students worked alone and the other half worked in groups
- Moderators guided discussions of small groups of students
- In one study, moderators were active vs. passive
- The goal was to evoke deliberation
Future development: What *developments* should be prioritized or avoided?

**Regulation of Nanotechnology:** What *regulations* should be in place or are needed?

- Students gave their final input in regards to
  - the risks and benefits of nanotechnology
  - Regulation of nanotechnology

- The goal was to get students to practice citizen input

- In addition, they were able to give feedback on the activities

Assignment 4: Final Input
Findings

A Sampling of our Effects
• **Semester 1 & 2**
  ◦ All conditions show knowledge gains
  ◦ When we’ve asked students to think critically, they’ve appeared to learn more if they were in the ‘alone’ scenarios condition
During the Engagement I...
1=Not at all, 2 =Just a little, 3 = Some, 4 = Quite a bit, 5 = A great deal

<table>
<thead>
<tr>
<th>Conscientious (Cronbach’s α = .82+)</th>
<th>Open-minded (Cronbach’s α = .70+)</th>
</tr>
</thead>
<tbody>
<tr>
<td>Gave careful consideration to all of the options presented.</td>
<td>Felt open to hearing new ideas about the topics.</td>
</tr>
<tr>
<td>Thought it was important to be thorough in my consideration of the issues.</td>
<td>Tried hard to understand perspectives that were different from mine.</td>
</tr>
<tr>
<td>Was concentrating hard.</td>
<td>Felt open-minded.</td>
</tr>
<tr>
<td>Felt focused.</td>
<td></td>
</tr>
<tr>
<td>Carefully evaluated the relevance of various arguments.</td>
<td></td>
</tr>
</tbody>
</table>

<table>
<thead>
<tr>
<th>Active Learning/Metacognitive (Cronbach’s α = .77+)</th>
<th>Closed-minded (Cronbach’s α = .72+)</th>
</tr>
</thead>
<tbody>
<tr>
<td>Explored topics related to the issues in order to satisfy my own curiosity.</td>
<td>Felt like my mind was already made up.</td>
</tr>
<tr>
<td>Checked myself to see how well I understood the issues related to the topics I was learning about.</td>
<td>Knew how I would feel about the topic even before doing the task.</td>
</tr>
<tr>
<td>Identified questions that I still had about the topics.</td>
<td>Felt like new information would not change my opinions.</td>
</tr>
<tr>
<td>Thought about how the topics related to other things I know.</td>
<td></td>
</tr>
<tr>
<td>Tried to find answers to my questions about the topics.</td>
<td></td>
</tr>
</tbody>
</table>

<table>
<thead>
<tr>
<th>Creative (Cronbach’s α = .85+)</th>
<th>Social (Cronbach’s α = .88+)</th>
</tr>
</thead>
<tbody>
<tr>
<td>Felt creative.</td>
<td>Discussed my ideas about the topics with others.</td>
</tr>
<tr>
<td>Used my imagination.</td>
<td>Talked to others about the topics to get their opinions.</td>
</tr>
<tr>
<td>Felt inspired.</td>
<td>Asked others what they thought about the topics and issues.</td>
</tr>
<tr>
<td>Worked to think of novel or inventive issues related to the topic.</td>
<td>Listened to what others thought about the issues.</td>
</tr>
<tr>
<td>Tried to be innovative in my ideas.</td>
<td></td>
</tr>
</tbody>
</table>

<table>
<thead>
<tr>
<th>Disinterested (Cronbach’s α = .89+)</th>
</tr>
</thead>
<tbody>
<tr>
<td>Was impatient to get this over.</td>
</tr>
<tr>
<td>Wished I was doing something else.</td>
</tr>
<tr>
<td>Felt bored.</td>
</tr>
<tr>
<td>Felt distracted.</td>
</tr>
<tr>
<td>Was uninterested in the task I was asked to do.</td>
</tr>
<tr>
<td>Thought this process was not worth my time.</td>
</tr>
<tr>
<td>Didn’t care at all about the activities and tasks.</td>
</tr>
</tbody>
</table>
• **Semesters 1 & 2:** Students in the critical thinking condition were *dis*engaged compared to control or other students.

• **Subsequently:** Moved to the use of “prompts.”
  ◦ Critical thinking students were *more actively* engaged (and a bit higher on most positive engagement factors),
  ◦ but also more *disinterested*.

• Effortful cognitive engagement may not be fun.

<table>
<thead>
<tr>
<th>Engagement Scale</th>
<th>Fall 2010 Feedback</th>
<th></th>
<th></th>
<th></th>
<th>Fall 2011 Feedback</th>
<th></th>
<th></th>
<th></th>
</tr>
</thead>
<tbody>
<tr>
<td>Active Learning</td>
<td>Mean 2010</td>
<td>1.72</td>
<td>.54</td>
<td>1.69</td>
<td>.53</td>
<td>3.00*</td>
<td>.71</td>
<td>3.27*</td>
</tr>
<tr>
<td></td>
<td>Mean 2011</td>
<td>3.00*</td>
<td>.71</td>
<td>3.27*</td>
<td>.78</td>
<td>3.00*</td>
<td>.71</td>
<td>3.27*</td>
</tr>
<tr>
<td>Conscientiousness</td>
<td>Mean 2010</td>
<td>1.84</td>
<td>.55</td>
<td>1.80</td>
<td>.52</td>
<td>3.54*</td>
<td>.69</td>
<td>3.87*</td>
</tr>
<tr>
<td></td>
<td>Mean 2011</td>
<td>3.54*</td>
<td>.69</td>
<td>3.87*</td>
<td>.65</td>
<td>3.54*</td>
<td>.69</td>
<td>3.87*</td>
</tr>
</tbody>
</table>

Note: * indicates significant differences.
Semester 3, 4, 5

- Critical thinking condition is associated with more **subjective knowledge** gains

- Effect appears to be best mediated by
  - Conscientious engagement (2 of 3 studies) (also often related to objective learning gains)
  - Lower closed-mindedness (1 of 3 studies)
  - Active learning engagement (1 of 3 studies)
• Qualitative coding of “final input” for “quality”

<table>
<thead>
<tr>
<th>Breadth/Depth</th>
<th>Variable Name</th>
<th>Correlation with NFC</th>
</tr>
</thead>
<tbody>
<tr>
<td>Breadth</td>
<td><strong>Count</strong> of topics (sum of 17 dummy variables)</td>
<td>Pearson Correlation = .43</td>
</tr>
<tr>
<td></td>
<td>Also: Number of new topics at post (not at pre)</td>
<td>Sig (2-tailed) = .07</td>
</tr>
<tr>
<td>Depth</td>
<td><strong>Meta-Oppos</strong> scale from 0-4 measuring with</td>
<td>Pearson Correlation = .12</td>
</tr>
<tr>
<td></td>
<td>0=no mention of alternative viewpoints, 1=mentions at least one alternative viewpoint, 2=mentions numerous viewpoints or describes one in some detail, 3=evaluates one view or describes more than one view, 4=evaluates more than one view)</td>
<td>Sig (2-tailed) = .636</td>
</tr>
<tr>
<td></td>
<td>Also: Consideration of Evidence</td>
<td></td>
</tr>
</tbody>
</table>
Critical thinking may benefit depth over breadth
- Students who did not receive CT prompts were more likely to mention additional topics than those who did receive prompts.

Critical thinking condition may benefit high NFC students, harm low NFC

- When receiving CT prompts
  - Students with a high NFC were likely to more deeply consider opposing arguments (than controls)
  - Students with a low NFC were actually less likely to consider opposing arguments (than controls)
• Not all students will embrace infusion of ELSI topics into their basic science course
  ◦ Some things help:
    • Timing of content, asking them about the importance first

• Try not to have the “research” aspect be salient (undermines credibility)

• Group moderators appear to be helpful

• There is a difference between positive cognitive and positive affective engagement

• Things that “should” work may not (or may not for everyone)
Thank You!

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