Feminist Interventions in Less than Feminist Spaces
Applying Feminist Pedagogies to the Large, Non-Majors Science Classroom

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Introduction

In my Biology 101 class, we’ve spent weeks studying DNA transcription, chromosome duplication and the like. We’ve spent weeks on it, yet, . . . we aren’t going to be geneticists, and it’s all just empty facts that we’ve learned but can do nothing with . . . . There are segues into global warming and touches on evolutionary theory, but mostly, it’s plod ahead, get this over with. (Rivard 2006).

The preceding quotation about non-majors biology, written by West Virginia University (WVU) student Ry Rivard, appeared in the student newspaper. In contrast to Rivard’s experience, according to the National Science Education Standards “science education is to . . . give students a foundation on which to base decisions they will face as citizens.” (NRC 1996, 107) Feminist scholar Karen Barad (2001, 237) argues that many scientific literacy projects have failed because “the goal of scientific literacy may not be compelling to many of the ‘scientifically illiterate’ who have already grasped its irrelevance.” Instead of “[s]tarting with an unchanged traditional curriculum and coating scientific facts with ‘relevant examples’ to make them go down easier” (237), Barad argues that attempts to help students see science as significant to their lives must fully engage with the nature of science as a social process. Barad identifies as inadequate the types of courses where a bit of philosophy or history is tacked onto the science content, where the science is watered down, or where social factors are overemphasized so that science seems to be only a product of culture. Overall, Barad wants to explore the “complex nature of the relationship between science and culture, rather than seeking causal explanations for one strictly in terms of the other.” (228) Rivard echoes her critique—he calls for more than simple examples.

This project is an attempt to move toward the above goals in the non-majors biology course that Rivard critiqued. Although the nature of this large enrollment course limited the scope of our project, we hoped that our admittedly limited intervention would provide some practical strategies that instructors could try. Additionally, in this report we hope to
build a dialogue between feminist literatures on science education and SENCER (Science Education for New Civic Engagements and Responsibilities) projects because we feel that each community has much to contribute toward enhancing student engagement and learning in large classes. Combining some of their approaches could be a fruitful strategy for future projects operating under constraints (lecture based formats, large enrollments, no graduate teaching assistant support, multiple sections with different instructors, etc.) similar to ours.

The SENCER project aims to answer Barad’s and Rivard’s challenges by ‘developing faculty expertise in teaching ‘to’ basic, canonical science and mathematics ‘through’ complex, capacious, often unsolved problems of civic consequence (SENCER).” Thus, “SENCER-ized” courses address the following goals: To encourage students to investigate the production of knowledge, participate in its construction and apply these skills to issues requiring civic engagement and responsibility.

SENCER does not claim to generate these pedagogies but provides resources and a supportive community for faculty who wish to implement them. In this respect, SENCER shares the aims of many feminist science organizations (e.g., The National Women’s Studies Association task force on science and technology), conferences (e.g., Inclusive Science in 2008 at the College of St. Catherine, St. Paul, MN), as well as various books and journal issues over the past two decades.

Feminist literature can provide helpful resources for SENCER projects. Feminist and other liberatory pedagogies link the natural sciences, the physical sciences and engineering with the social sciences, the arts and the humanities (Barscht 2004; Grasso et al. 2004; Mayberry et al. 2001; Riley 2004; Rosser 1997). Democratic pedagogies encourage collaboration and student knowledge construction (Cassidy and Cook-Sather 2003; Barton and Osborne 2000). Finally, these various pedagogies address the role of science in social justice projects (Bartsch 2004; Rosser 1997). Many share SENCER’s goals to link content with pressing societal problems accessible to diverse groups of students, for instance by replacing military and sports examples (Whitten and Burciaga 2000) and including social justice issues such as environmental racism (Mayberry and Rees 1997; Schneiderman and Sharpe 2001). Girls may be attracted to science for societal benefit rather than strictly for the sake of discovery (Yanowitz 2004). Courses emphasizing this are attractive to female students (Jessup et al. 2005). Further, female engineering students responded more positively toward problem based learning than did male students (Du and Kolmos, 2009). However, some attempts to engage female students in majors classes have not succeeded in part because students think these new approaches take too much time, they don’t like the collaborative nature, and they aren’t sure if they have “learned the right thing.” (Whitten and Burciaga 2000, 219-220)

Unfortunately, the structure of many introductory non-majors science classes is particularly challenging for feminist pedagogies, which are often based on personal engagement with students. Classes with hundreds of students typically emphasize lecture and a small number of high-stakes exams, rather than individual contact, collaborative learning, and discussion. These courses are currently fixtures at many large universities. However, to attain diversity goals and promote scientific understanding, it is critical to address large courses. For example, when students enrolled in non-majors biology at WVU were asked to write out their concerns about taking the course on the first day of class, roughly two times as many female as male students volunteered statements such as “I’m not a good science student”, “I’m anxious about this class” and similar statements indicating negative experiences in previous science courses. In spite of these challenges, an analysis of a range of SENCER courses indicated that large courses were able to engage students with as many aspects of science practice as small courses (Utz and Duschl 2009). SENCER-ized courses help women, and non-science majors, gain confidence in their scientific abilities and interest in science (Weston et al. 2006). Thus, feminist science instructors could draw on resources from SENCER when faced with large classes.

Our project aims to integrate feminist and SENCERized pedagogies by exploring the interactions between science and the news media, and by doing so in a format that encourages students to develop their own connections to the material, to express themselves, and to develop connections with their peers. We hypothesized that connecting science information to issues of civic importance would encourage student confidence in their ability to apply scientific information to their lives and would also increase their interest in science. We expected women, and other groups traditionally underrepresented in science, to show especially significant gains. We hoped to significantly improve the student experience in a large, introductory course, while still working within
the limitations and logistical challenges posed by curricular sequence, shared course policies, high student-to-instructor ratio, and classroom size. We specifically aimed to find ways to incorporate feminist strategies such as individual contact, collaborative learning, and discussion. To accomplish this goal we used low-stakes, and relatively quick to grade, written assignments that aimed to get students discussing science in their own words with their peers.

Methods
Biology 101 is an introductory, non-science majors biology course with 250 students per section which fulfills a general education requirement. The course covers the cell, genetics, evolution, and ecology in three hour-long lectures and one two-hour lab per week. It is taught in a large lecture hall with fixed, stadium-style seating; the instructors often rely on a wireless microphone to be heard. In the fall semesters, there are six sections taught by four different instructors who use a common text. In the spring two instructors teach two sections. These instructors carry out all aspects of the course without assistance from graduate teaching assistants or other paid helpers. Teaching styles vary: several instructors adhere almost exclusively to lecture, while others integrate varying degrees of interactive pedagogy. Efforts are made at uniformity between sections, while still allowing instructors some small latitude: all sections adhere to a similar sequence and timing of topics to match the required laboratory curriculum, similar grading policies are used, and assessment consists primarily of four multiple choice exams. The instructors have mutually agreed to allocate a small percentage of points (10–25 percent) for attendance, homework, or in-class participation to allow for personal preference and variation in teaching styles while keeping the grading system and student perceptions of “fairness” between course sections comparable. Students are primarily non-majors, although some science programs of study with general curricular goals do require Biology 101 because it is less intense than the majors course. The most common majors include general studies, education, sports management, criminology/investigation, psychology, and exercise physiology. Efforts underway to enhance student learning at the beginning of this project included linking of lab and lecture topics, online multiple choice homework questions based on reading assignments, and use of “clickers.”

We used the “Biology in the News” approach in a single lecture section during spring 2007 (hereafter referred to as the “modified” section). We compared student attitudes in this modified section to students in two “traditional” sections (without the additional content described below) taught during fall semester 2006 (see Table 1). The same instructor taught all of these sections. In the modified “Biology in the News” section, we left the overall sequence of the material untouched in order to align with curriculum in the laboratory and other lecture sections. Most of the changes involved weekly written homework (graded by undergraduate TAs who received course credit) to maintain the level of student engagement in biology between exams, including six “Biology in the News” assignments. While such changes appear minor, these were the first assignments in this course to give students an opportunity to write about science in their own words and to include topics of personal interest, rather than merely to select pre-written multiple choice answers related to reading or lecture topics. We also incorporated weekly “guiding questions” related to reading assignments, which were written by the undergraduate TAs and randomly assessed through daily personal response “clicker” questions and infrequent, unannounced collection of student work. Both traditional and modified lecture sections utilized “clickers” and interactive

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<td>Participation credit, via “clicker” questions</td>
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<td>Homework Components</td>
<td>Electronic multiple choice quizzes</td>
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<td>Guiding questions for reading</td>
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<td>Written, news-focused homework</td>
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<td>Multiple-choice Exams</td>
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<td>75/15/10</td>
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<td>Undergraduate Teaching Assistants</td>
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*The content of these components (lecture, electronic quizzes, and exams) were virtually identical between both courses.
demonstrations using models; the modified section also included a small amount of group work.

We expected students to be able to connect biology content to "real world" issues, identify differences between science writing and popular reporting of science, evaluate the content of a news article about a scientific discovery and discuss the flow of scientific information from the lab to the media. To achieve these learning outcomes, we invited Ralph Hanson, assistant dean of the WVU School of Journalism to guest lecture about the process of science being turned into news articles. He discussed the different understandings of key terms like objectivity and theory that are employed by journalists and scientists and how that affects the reporting of science. We also selected a press release about a study where taking aspirin decreased post-menopausal women's risk of pancreatic cancer. We asked the students to compare the press release with the original scientific article's abstract, and to evaluate the quality of the press release in terms of how effectively it conveyed the science. We then modified a search statement assignment “Translating English into Computerese” from Teaching Information Literacy Concepts: Activities and Frameworks from the Field, Active Learning Series No. 6 (Trudi E. Jacobson and Timothy H. Gatti, Contributing Editors). Students used their search terms find an article about a scientific topic of their own choosing in Lexis-Nexis, a database that searches newspapers, magazines, and some journals. The previous assignments encouraged development of basic skills that the later more collaborative, personalized assignments required. To encourage reflection, we developed a discussion board that required students to post a news article for comment from their classmates regarding connections to class, the quality of the report of the science, and the social and civic significance that the reporter gave the work. One-half of the group posted an article and the other half responded with a critique. The roles were reversed on the next discussion board.

We used both qualitative and quantitative assessments. Our quantitative measure was the SENCER Student Assessment of Learning Gains (SALG; www.salgsite.org). We compared SALG survey results between the 2006 traditional sections and the 2007 modified section. Students used a confidential identification number so all responses were anonymous. Multiple questions were grouped into general categories of items indicating confidence and interest in science. Students identified their level of interest, confidence or agreement/disagreement using Likert scales. This version of SALG had pre- and post- versions allowing instructors to compare student responses at the beginning and end of the course. Pre-course questions had the following format: Presently, I am confident that I could understand the scientific side of a debate about evolution in my own school district. Post-course questions were modified in the following way: After finishing this class, I am confident that I could think critically about scientific findings I read about in the media.

Qualitative assessment information was collected through free-response SENCER SALG questions. The SALG also collected demographic data, as well as information about which activities helped students learn. The SALG pre-survey was administered within the first month of class, whereas the students completed the post-survey during the last two weeks of class. Students were offered a small amount of extra credit (two percent of course grade). According to the WVU IRB procedures at the time of this research, the study protocol was submitted to the associate dean for research of WVU’s Eberly College of Arts and Science and was declared “exempt.”

The three sections enrolled approximately 750 students (250 per section). A total of 407 students (174 males, 229 females, and four of unknown sex) completed both the pre- and post- surveys. Among those students, twelve were African American (eight female), eight were Asian or Pacific Islander (seven female), three were Hispanic (two female), thirteen did not record their ethnicity (six female, three sex not recorded) and 371 were Caucasian (206 female, one sex not recorded). We also collected information on the students’ ages, year in school and current GPA, as well as their reason for taking the course. Using a Kruskal-Wallis test, we found no significant differences in ethnicity or sex among the three sections; however, students in the modified section (spring 2007) were older, further along in their studies and had higher GPA’s than in the traditional sections (fall 2006). We controlled for these
differences in the statistical analyses by including these variables as covariates. Additionally, there were differences among students in their motivation for taking the course between the modified and one of the traditional sections: students in the modified section were less likely to be taking the course because it was a prerequisite for another course. We expect this was related to the fact that these students were further along and were probably fulfilling general education requirements, thus we did not control separately for this. Motivation was not significantly different among the other sections. We pooled the data from the two traditional sections for comparison with the modified section using repeated measures multiple analysis of covariance (MANCOVA). For the purposes of analysis, we used the mean Likert scores for the confidence and interest groups of questions on the SALG, except for the course specific questions that we added, which were analyzed individually.

Results
Student confidence and interest increased in both the modified and traditional sections. However, only confidence gains were significantly greater in the modified In the News course than the traditional course (Figure 1, $F = 22.621$, $df = 1,387$, $p < 0.001$). No significant differences between the modified and traditional course were observed for gains in interest. There were no significant effects of sex or ethnicity on either confidence or interest gains. Gains were also significantly greater in the modified course for questions in which students rated their ability to apply specific topics from the course to their daily lives in the areas of getting information about genetic issues affecting their families ($F = 6.774$, $df = 1,364$, $p = .008$), understanding the scientific side of the debate over evolution ($F = 8.507$, $df = 1,364$, $p = .004$), weighing scientific evidence about environmental issues ($F = 5.536$, $df = 1,364$, $p = 0.019$), but not understanding an article about a new type of biotechnology ($F = .036$, $df = 1,364$, $p = .851$). Since the course did not end up covering information about biotechnology, this result is to be expected. There were no effects of sex or ethnicity on gains in these areas; students in all groups showed the same degree of gains.

When students were asked how much thirty-four different items helped them learn, “links to recent news” ranked twelfth

![Figure 1. Increased Confidence. Overall, students in the modified section had significantly higher gains in “confidence” items but not “interest” items on the SENCER SALG than students in the traditional sections. Repeated Measures MANCOVA.](image1)

![Figure 2. Applying Biology to Everyday Life. Students reported significantly higher gains in confidence to do tasks related to curriculum topics in the modified course in all areas except biotech. Repeated Measures MANCOVA.](image2)
highest, “Biology in the News” homework ranked twenty-fourth, and “Biology in the News” discussion boards ranked thirty-second (see Figure 3 for complete list). When students listed the assignments and activities that most helped them learn in the SALG free-response section, the following were mentioned most frequently:

1. “Clicker” questions;
2. Lecture;
3. Demonstrations or models;
4. Online quizzes;
5. Lecture examples and slides;
6. “Biology in the News” homework;
7. Lecture notes;
8. Lab activities;
9. The textbook; and
10. Guiding questions.

Student comments indicated that among the “Biology in the News” assignments, they preferred the discussion boards for their interactive qualities and the chance to relate a variety of topics to class materials (Table 2). However, approximately fifteen percent of survey comments suggested eliminating or changing “Biology in the News” assignments, with one of the most common suggestions being to better link the assignments to lecture content (Table 2).

**Discussion**

Our study illustrates that even limited feminist interventions can accomplish positive changes in the student experience. As we predicted, connecting science information to issues of civic importance enhanced student confidence in their ability to apply scientific information to issues relevant to their lives—even with just minor changes to course format and content. However, although we saw gains in student interest in both the traditional and modified sections, we did not see a greater impact on student interest in the modified section. Non-science majors, such as our students, may gain confidence in their abilities but not interest in taking further science courses because they are already committed to a non-science path that precludes more science coursework (Bower et al. 2007). The limited changes we made to lecture and the lack of its integration with the “Biology in the News” theme

![Figure 3](image-url)
may have further limited the impact on student interest, since lecture was still the most visible and time-consuming component of the course. “Topic fatigue” regarding “Biology in the News” could certainly be a factor; students who are asked to immerse themselves in a topic can grow tired of it by the final assessment period (Pike and Hanson 2007), thus mitigating the impact of being able to explore topics of personal interest. However, we contend that an increase in student confidence in one’s ability to digest and apply science to one’s personal life, such as our results indicate, is a worthy achievement, meriting further exploration.

We expected women, and other groups traditionally underrepresented in science, to show especially significant gains. However, although we saw overall gains for all students, we did not see greater impacts on these specific groups. Due to the small number of minority students in the study population, it is difficult to draw meaningful conclusions. However, we did find overall positive impacts on both male and female students, and for both whites and people of color, as a result of our intervention. Other similar approaches have also positively impacted the confidence and interest of both male and female students (McEneaney and Radeloff 2000). However, the mechanisms behind these gains are an important area for future research. Overall, we saw gains by both males and females, with no differences in magnitude between the sexes. However, it could be possible that the reasons for the gains differ between the sexes. For example, although both male and female students engage more positively with science when the content is linked to issues relevant to the student, the specific interest areas frequently differ between the sexes (Teppo and Rannikmäe, 2003; Gedrovics, 2006). Thus, the mechanisms by which we achieved an impact might also differ between the sexes. To address this question, our future research will examine more closely the qualitative responses and selected news topics of male and female students.

This study’s results also highlight an important issue to address in implementing meaningful curricular change: integrating societal relevance into high-stakes as well as low-stakes assessments. Some of our students who identified the “Biology in the News” assignments as fun or educational did not see them as useful to their learning because of a perceived gap between these assignments and the lecture content and tested material. We expect this factor to underlie the relatively low ranking of the discussion boards among the items that students identified as helpful to their learning. Finding meaningful ways to gain student buy-in for innovative pedagogies in large, non-majors classes is a key step toward the enhancement of student learning. An inherently conservative student approach to learning, particularly in courses outside their major, requires that instructors make sure that integrated content is seen by students as relevant to the course assessments. This is especially important in large science classes which require

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<th>Table 2. Samples of Student Comments (Free Response, SALG Post Assessment)</th>
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<td><strong>Positive Comments</strong></td>
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<td>I think I liked [the Biology in the News discussion boards] best because they relate more to real life, and I don't think they felt that much like homework.</td>
</tr>
<tr>
<td>[Discussion boards] allowed me to do research about topics that we discussed in class and get feedback from my fellow classmates. I think that it is a good interaction between students and it helps make a big class not so anonymous. It also helped me become more familiar with using scientific websites that I could possibly use in the future on a paper.</td>
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<tr>
<td>I enjoyed searching my topic because it gave some freedom and it helped me learn a little more about the topic I was interested and didn’t force one on me.</td>
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<tr>
<td>Most courses you learn things and you think, . . . “How is this related to my life?” These two [discussion boards] proved that biology is a part of our lives and is constantly in the news.</td>
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multiple choice testing and where students may have been conditioned to succeed by memorizing rather than engaging with material in assignments that are reflective, research and writing intensive. Inclusion of societally relevant material on exams, as well as more obvious integration of the biological content into personally engaging, socially relevant homework, may improve student perceptions of these activities in the future. Future research should examine the impacts of more explicit linkages among material in lecture, and on high and low stakes assessments.

An additional reason behind this student “resistance” could also be that our intervention did not go far enough in answering Barad’s and Rivard’s calls to explore the “embeddedness” of science within a societal context. Our conservative efforts thus far to maintain cohesion between course sections and curricula limited the degree of our curricular changes. Furthermore, the lack of a greater impact on students’ interest in science than in the traditional course may be explained because many students do not find the news to be particularly relevant to their lives or to be especially interesting or engaging. Increasing student awareness of and engagement with current events, however, still seems a worthy goal. In other news related projects, such student engagement has been critical for success. McCullough (2006) asked students to summarize an article and reflect on why they picked it. She found that articles linked to students’ majors or non-scholastic interactions were more likely to be selected. The “Chemistry in the News” project at the University of Missouri not only links chemistry with current societal issues; but also employs peer review of portfolios, collaborative group work, and online tools to build a sense of community in large chemistry courses (Carson et al. 2006; Glaser and Carson 2005). The assessment of that project found that those students who came into the course expecting that connecting course material to societal issues would make it more interesting and easier to understand had more positive attitudes toward the subject and the assignments by the end of the course. We agree with their advice that instructors must discuss with students how the societal connections and projects will facilitate learning at the beginning of the course.

Our results indicate that, in addition to the logistical problems with pedagogy reform in large classes, getting students on board can be challenging. Encouraging students to self-identify the relevance of science to their lives is an integral part of both feminist and SENCERized goals. In this area, we were successful as a number of the student comments indicated that they either valued freedom to select their own topics or that they wanted more freedom in how they identified links to course content material. Thus, in future efforts we plan to build on this response to enhance student engagement. Given that students appeared to respond positively to the discussion boards due to the possibility for interaction with their peers, we are exploring means of using this method with other topics that students may find more relevant, such as medical issues. Fink (2009) used cancer as an issue with which to engage introductory biology students by integrating material on treatment with personal narratives of those afflicted by cancer. Feminist approaches provide other useful strategies. Introducing feminist analyses and women’s studies content helps students see how to balance work and life (Whitten and Burciaga 2000; Rosser 1997) and deal with sexual harassment and other forms of discrimination (Weasel et al. 2000). Other successful courses highlight the overlooked contributions of members of underrepresented groups, such as women in ecology (Damschen et al. 2005) or non-Western approaches to thermodynamics (Riley 2003). The feminist approach defines diversity broadly and can benefit nearly all students; for example, engineering education programs train people to work in diverse teams and also to develop technologies for diverse users (Ihsen and Gebauer 2009). These types of topics could be used to explore the personal issues faced by scientists in their careers or applications of science and technology to a variety of societal issues. Our future efforts will focus on carefully blending topics and resources to foster student personal engagement with course content. We expect that explaining the reason for and benefits of added societally relevant material, as well as its more complete integration into the course, will be reflected in further gains in student interest, confidence, and engagement with both biology and current events.

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References


