Ripped from the Headlines: Using Current Events and Deliberative Democracy to Improve Student Performance in and Perceptions of Nonmajors Biology Courses†

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Despite the importance of scientific literacy, many foundational science courses are plagued by low student engagement and performance. In an attempt to improve student outcomes, an introductory biology course for nonscience majors was redesigned to present the course content within the framework of current events and deliberative democratic exercises. During each instructional unit of the redesigned course, students were presented with a highly publicized policy question rooted in biological principles and currently facing lawmakers. Working in diverse groups, students sought out the information that was needed to reach an educated, rationalized decision. This approach models civic engagement and demonstrates the real-life importance of science to nonscience majors. The outcomes from two semesters in which the redesign were taught were compared with sections of the course taught using traditional pedagogies. When compared with other versions of the same course, presenting the course content within a deliberative democratic framework proved to be superior for increasing students' knowledge gains and improving students' perceptions of biology and its relevance to their everyday lives. These findings establish deliberative democracy as an effective pedagogical strategy for nonmajors biology.

INTRODUCTION

Undergraduate courses geared toward nonmajors pose a particularly difficult pedagogical challenge. Studies on the biology of learning have shown that learning is most successful when new material is placed within the framework of existing knowledge and when the learner is interested in the new material (2, 11). Students enrolled in classes that are geared toward nonmajors typically have limited knowledge of the field and a more diverse array of interests and backgrounds, which makes connecting the subject matter to prior knowledge or common interests especially difficult for the instructor. To combat these problems, instructors increasingly turn to active learning, which has been shown to be more effective than lecturing for improving student engagement, learning, and retention (3, 9, 13). However, active learning is not a cookie cutter approach and requires significant planning on the part of the instructor in order to be effective.

One lesser known active learning strategy that is effective in a number of academic settings is deliberative democracy (DD), a form of guided dialogue centered on thoughtful and transformational questions that models how our nation's leaders draft and implement policies (7, 23). During this dialogue, participants gather and discuss information to reach a consensus concerning a problem that affects each participant in the deliberation (7). As a tool in the classroom, DD calls on students to actively participate in a decision-making process where the decision to be made has a broad and collective impact (19). DD has almost exclusively been used in the humanities, where it has been shown to improve various student learning outcomes and develop important interpersonal skills such as verbal communication and reasoned decision making (4, 5, 19, 23). Additionally, DD promotes an appreciation for diverse perspectives and models the democratic process to foster civic-mindedness, a characteristic that has been waning in recent decades (5, 12, 15).

Although DD seems unrelated to the life sciences, it is primarily in the civics arena that most nonscientists will encounter topics of science. Recently, DD was developed for and employed in a nonmajors biology course (23). However, it is unclear whether DD offers any advantages over more traditional pedagogies in terms of student performance in the sciences. In order to better address this, I redesigned my introductory biology class for nonmajors to present the course content within the framework of DD. Students who completed the redesigned course were surveyed for knowledge acquisition and changes in their feelings about biology and its relevance to their everyday lives. The results from the redesigned course were then compared with other...
sections of the course taught using traditional pedagogies. Because it has the potential to establish the relevance of course material, I hypothesized that DD would improve both students’ performance in and perceptions of biology. Here I present the specifics of my course design and data from two semesters in which the redesigned course was taught that demonstrate that, consistent with the hypothesis, DD proved to be effective with respect to all assessed measures of student learning.

**METHODS**

Course design

This course redesign occurred in select sections of BIO100 Principles of Biology at the University of Montevallo, a small public liberal arts institution in Montevallo, Alabama. BIO100 is a four-credit hour course with three lecture hours and one two-hour laboratory per week. The course provides nonscience majors with an overview of cell structure and function and plant and animal ecology. Approximately 15 sections of the course are taught per year by five full-time and/or three adjunct faculty members with a maximum enrollment of 30 students per section. While each instructor is given the freedom to format the course to their preference, there is a defined list of concepts that must be covered in all sections, and a standardized content survey is administered to all students who complete the course to assess student learning.

Prior to redesigning the course, I divided the course material into three instructional units—human development, evolution, and ecology. While an active learning exercise was incorporated about once a week, the course was primarily traditional lecture with cookbook-style lab activities. Each unit culminated in a multiple-choice exam, collectively accounting for 55% of the overall semester grade. The remainder of the semester grade was based on laboratory activities (30%) and homework or in-class activities (15%).

The redesigned sections of the course used the same instructional units and added a unit on human physiology, as described in Table 1. The greatest difference between the two versions of the course was how the material was presented. Rather than using a traditional lecture format, the redesigned course involved presenting the content within the framework of a DD exercise. Specifically, I opened each unit with a well-publicized question facing lawmakers and/or voters related to the scientific material to be covered during the unit. Table 1 includes a list of the questions that were used during the two semesters that the redesigned course was taught. I chose topics that received significant coverage in mainstream media within three months of beginning the unit. I divided each section of the course into six groups of five students. Groups were designed to optimize diversity with respect to age, gender, race/ethnicity, major, grade point average (GPA), and time since last completing a biology course. Each group was then tasked with identifying and seeking out the information necessary to reach an informed decision about the policy question that was posed. While students worked individually to gather information, they had to evaluate the validity and importance of the information as a group. Ultimately each group assimilated the thoughts and opinions of each member into a consensus statement that was turned in for grading and presented to the class at the end of the unit. The general organization of the DD exercises in each unit is depicted in Figure 1.

Reflecting the different pedagogy, the redesigned course had a distinctly different division of class time among activities (Fig. 2A). The DD exercises accounted for close to 20% of class time. The remainder of the time in each unit was devoted to understanding the biological concepts that underlie the democratic exercise. Some of this was done through traditional lecture, but much of it occurred through class discussions of assigned reading and small active learning exercises like case studies. No matter the format that was used to present the material, the material was linked to the DD exercise in some way so that the initial policy question was a constant theme throughout the unit. Laboratory exercises were also performed in the redesigned course, but they were inquiry-based and also tied into the DD exercise. These changes reduced the amount of time spent lecturing by more than two-thirds. Table 2 shows a list of activities performed during one instructional unit of the course to demonstrate the persistence of the topical theme.

While it was important that students learn basic biological principles in the redesigned course, the use of DD emphasizes the importance of applying that knowledge to seemingly unrelated scenarios. As such, the manner in which students were assessed changed with the course redesign. Figure 2B shows the breakdown of semester grades for the previous version of the course compared with the redesign. The same number and types of exams were administered in the redesigned course as in the traditional lecture format. However, the exams only accounted for one-third of the semester grade compared with more than half of the semester grade in the previous version of the course. Products of the students’ work on the DD exercises accounted for another third of the semester grade. Although the redesigned course used roughly the same number of laboratory exercises as the previous version, they carried a lower weight. The impact of homework and in-class activities, collectively referred to as “learning exercises,” remained unchanged.

**Evaluation of student outcomes**

The methods for assessing student outcomes were found to be in compliance with federal guidelines and approved by the University of Montevallo Human and Animal Subjects Research Committee (HASRC). Students signed an informed consent form prior to completing each survey, and no identifying information was included on the survey. Data from each section of the course were pooled, and differences between mean values were determined using Student’s t-test, unless otherwise noted.
Before redesigning the course, I taught one section in fall 2012 and one section in spring 2013 using traditional pedagogies. Data from exam scores were pooled from these two sections of the course and compared with pooled data from four sections of the redesigned course that were taught in spring 2014 and spring 2015.

Appendix 3 contains the survey that was administered to students to evaluate the impact of the course redesign on student outcomes. The survey consisted of a demographics questionnaire and 50 questions that were subdivided into two parts—a survey of students’ attitudes toward biology and a survey of factual biology knowledge. The first section of the survey used a five-point Likert scale and consisted of three types of questions—questions regarding the students’ feelings toward biology, their beliefs concerning the importance of certain topics, and their perceived understanding of these topics. This section of the survey was adapted from Armbruster et al. and Weasel and Finkel (3, 23). The second section consisted of 20 multiple-choice questions to assess factual knowledge gained by the students. These questions were taken directly from the general education assessment for the course that is used by all professors at the University of Montevallo.

### TABLE 1.
Organization of the redesigned course.

<table>
<thead>
<tr>
<th>Unit Title</th>
<th>Student Objectives</th>
<th>Deliberative Democracy Topic Spring 2014</th>
<th>Deliberative Democracy Topic Spring 2015</th>
</tr>
</thead>
<tbody>
<tr>
<td>Human Development</td>
<td>Students will be able to describe the unifying features of biology including the scientific method, evolution, the cell theory, and the definition of life. Additionally, students will have a foundational understanding of genetics and its role in inheritance, reproduction, and cell function.</td>
<td>Should companies be permitted to sell genetic testing kits directly to the consumer?</td>
<td>Should medical claims made on television be regulated? If so, how?</td>
</tr>
<tr>
<td>Genetic Technologies and Evolution</td>
<td>Students will be able to describe major advances in genetic technologies as well as the importance of such advances for various fields of biology like agriculture and healthcare. Students will also be able to define evolution and describe and recognize the various processes that drive evolution.</td>
<td>Should food manufacturers be required to label foods that contain genetically modified ingredients?</td>
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</tr>
<tr>
<td>Human Physiology</td>
<td>Students will be able to recognize the major organ systems of the body and be able to discuss how they function normally. Students will also be able to discern how changes in homeostasis will affect an individual.</td>
<td>Should the required nutrition labels on food packages be redesigned? If so, how?</td>
<td>Should the state grant non-medical exemptions from vaccination requirements?</td>
</tr>
<tr>
<td>Ecology and Biodiversity</td>
<td>Students will be able to describe how diverse populations interact with each other and their environments. Additionally, students will be able to discuss the impacts of humans on these delicate interactions.</td>
<td>What global policies, if any, should be implemented to lessen human impact on biodiversity?</td>
<td>How should endangered juvenile salmon be protected from predators like cormorants?</td>
</tr>
</tbody>
</table>

**FIGURE 1.** Flow chart depicting the general organization of each unit in the redesigned course. “n” refers to the number of class meetings in the unit. Examples of the Policy Introduction Worksheet and Final Policy Worksheet are available in Appendix 1 and Appendix 2, respectively.
The entire survey was administered during the first and last weeks of class to students enrolled in the redesigned course and students enrolled in two sections of the course taught by a different professor who used a mixed format of traditional lecture and active learning. The design of these sections of the course was similar to my teaching of the course prior to the redesign. Approximately half of the class time was spent in traditional lecture. The remainder of the time was split between cookbook-style laboratory exercises and various active-learning exercises such as small group problem-based learning activities. The survey was also administered during the last week of class to students enrolled in one section of the course taught by a third professor who uses a strict lecture format. Appendix 4 summarizes the demographics of the three student cohorts, which differed only modestly in gender, race, and college affiliation.

RESULTS

Deliberative democracy improved students’ factual knowledge gains

To determine the effects of DD on knowledge gains, average exam scores of students who completed the redesigned course were compared with those of students who completed the course with me prior to the redesign. As shown in Figure 3, students enrolled in the redesigned course scored 13.5% higher on the human development and 10.9% higher on the evolution semester exams compared with students who completed the course prior to the redesign. There was no difference in student performance on the ecology semester exam.

Students who completed sections of the course taught by different professors using either traditional lecture format or a mixture of lecture and active learning performed worse overall on the general education assessment for the course. As shown in Figure 4A, students who completed the redesigned course scored 21% higher than students who completed the traditional lecture course and 9.4% higher than students who completed the mixed-format course. While students in the mixed-format course performed better than the traditional lecture course, this difference was not statistically significant. When questions from the general education assessment were divided according to content area and performance at the end of the semester was compared with the beginning of the semester, students in the redesigned course experienced greater gains in content knowledge overall and for the human development and evolution units than students in the mixed-format course.

Deliberative democracy improved students’ perceptions of biology

To determine the effects of the course redesign on students’ perceptions of biology, students enrolled in the mixed-format version of the course and the redesigned course were asked whether they viewed various biological concepts as important and to self-report their current understanding of these same concepts. Students’ responses at the end of the semester were compared with their responses at the beginning of the semester. Cancer, genetic testing, genome sequencing, genetically modified organisms (GMOs), vaccinations, climate change, and human population growth were the biological concepts used for the survey. National debt, economic growth, and poverty were included as negative controls, since none are directly related to the content covered in the biology course.

More than 80% of students enrolled in each section of the course rated each of the concepts as important at the beginning of the course. Therefore there was little room for
However, few students reported understanding any of the concepts at the beginning of the semester. Students enrolled in both course formats reported significant improvements in self-reported understanding of the concepts at the end of the semester. These improvements were more pronounced in the redesigned course, as illustrated in Figure 5A. The largest gains were seen in genetic testing and genome sequencing, where students enrolled in the redesigned course reported 9.5-fold and 19.8-fold increases in understanding of these concepts, respectively, compared with 2.5-fold and 1.9-fold for the mixed-format course. The non-biology concepts showed minimal gains in understanding, with negligible differences between course formats. When these topics were divided according to instructional unit, the greatest gains in self-reported understanding were seen for the human development and evolution sections of the redesigned course (Fig. 5B), consistent with students’ actual knowledge of topics in these units as measured by performances on semester exams (Fig. 3) and on the general education assessment (Fig. 4B).

Students’ perceptions of biology were analyzed by surveying their self-reported feelings about the subject. Students were asked whether they view biology as interesting, fun, not stressful, stimulating, enjoyable, and relevant both at the beginning of the semester and again at the end of the semester. Fewer than half of all students reported positive feelings (agreeing or strongly agreeing with the statements) change in whether students perceived them as important (Appendix 5). However, few students reported understanding any of the concepts at the beginning of the semester. Students enrolled in both course formats reported significant improvements in self-reported understanding of the concepts at the end of the semester. These improvements were more pronounced in the redesigned course, as illustrated in Figure 5A. The largest gains were seen in genetic testing and genome sequencing, where students enrolled in the redesigned course reported 9.5-fold and 19.8-fold increases in understanding of these concepts, respectively, compared with 2.5-fold and 1.9-fold for the mixed-format course. The non-biology concepts showed minimal gains in understanding, with negligible differences between course formats. When these topics were divided according to instructional unit, the greatest gains in self-reported understanding were seen for the human development and evolution sections of the redesigned course (Fig. 5B), consistent with students’ actual knowledge of topics in these units as measured by performances on semester exams (Fig. 3) and on the general education assessment (Fig. 4B).

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**TABLE 2.**
Sample calendar of activities from the Genetic Technologies and Evolution unit of the redesigned course.

<table>
<thead>
<tr>
<th>Day</th>
<th>Activity and/or Topic</th>
<th>Objective(s)</th>
</tr>
</thead>
<tbody>
<tr>
<td>1</td>
<td>Deliberative Democratic Exercise: Labeling of Genetically Modified Foods</td>
<td>Students are introduced to the deliberative democratic exercise for the unit and identify the information that will be necessary to adequately address the question.</td>
</tr>
<tr>
<td>2</td>
<td>Discussion: Genetic Engineering Video: &quot;The Eyes of Nye – Genetically Modified Foods&quot;</td>
<td>Students are introduced to genetic engineering and learn how it is used in various industries, including for the production of food.</td>
</tr>
<tr>
<td>3</td>
<td>Lab: Detection of Genetically Modified Foods</td>
<td>Students bring food from home to test for the presence of GMOs using PCR and gel electrophoresis.</td>
</tr>
<tr>
<td>4</td>
<td>Discussion: Gene Therapy</td>
<td>Students learn about other genetic technologies and their uses in medicine.</td>
</tr>
<tr>
<td>5</td>
<td>Video: NOVA “Cracking the Code”</td>
<td>Students learn about DNA sequencing.</td>
</tr>
<tr>
<td>6</td>
<td>Lecture: Photosynthesis and Respiration</td>
<td>Students learn about the production of nutrients by plants and how these nutrients are used for energy.</td>
</tr>
<tr>
<td>7</td>
<td>Discussion: Mechanisms of Evolution</td>
<td>Because one of the major concerns about genetically modified plants is their potential ecological impact through horizontal gene transfer, students learn about it and other mechanisms that influence evolution as well as the importance of evolution.</td>
</tr>
<tr>
<td>8</td>
<td>In-Class Activity: Natural Selection</td>
<td>Students learn about the importance of natural selection and how it functions as a major driving force of evolution.</td>
</tr>
<tr>
<td>9</td>
<td>Lab: Evolution in a Tree Population</td>
<td>Students simulate the connection between an organism and its environment and visualize the effects of selective pressures on populations over time.</td>
</tr>
<tr>
<td>10</td>
<td>In-Class Activity: The Evidence for Evolution</td>
<td>Students work together to locate evidence of the impact of evolution.</td>
</tr>
<tr>
<td>11</td>
<td>Discussion: Evolution of Disease</td>
<td>Students investigate the impact of evolution by studying a crop disease and a human disease. Students also discuss the impact of chemicals such as pesticides and antibiotics on populations.</td>
</tr>
<tr>
<td>12</td>
<td>Article Discussions</td>
<td>Students read and discuss a mainstream media article and a scientific research article related to the deliberative democratic exercise.</td>
</tr>
<tr>
<td>13</td>
<td>Final Deliberation</td>
<td>Students share information that they have gathered over the course of the unit with their groups. Together, each group constructs a consensus statement that represents the collective opinion of the group and supports the statement with references gathered by members of the group. Groups present and defend their statements to the class and the class formulates an overarching consensus statement.</td>
</tr>
<tr>
<td>14</td>
<td>Exam</td>
<td>Students complete a multiple-choice exam over biological concepts discussed during the unit.</td>
</tr>
</tbody>
</table>

GMO = genetically modified organism; PCR = polymerase chain reaction; DNA = deoxyribonucleic acid.
toward biology at the beginning of the semester, but this number increased significantly at the end of the semester irrespective of the pedagogical format. However, as was seen with students’ self-assessment of understanding, this effect was much more pronounced in the redesigned course, as illustrated in Figure 6A. The greatest difference was seen for the statement that “biology experiments are fun,” which resulted in a 2.1-fold increase in the redesigned course compared with a 1.5-fold increase in the mixed-format course.

Students also reported significant gains in their perceptions of the importance of biology for their non-academic lives. While students enrolled in the mixed-format course reported more pronounced gains than students enrolled in the redesigned course with regard to the perception that biology is important for their future career paths, all other metrics of importance—for politics, students’ personal lives, and citizenship—demonstrated larger gains in the redesigned course (Fig. 6B). The greatest difference was in terms of biology being important for politics, which resulted in a 2.1-fold increase in the redesigned course compared with just 1.4-fold in the mixed-format course.

DISCUSSION

The results of this study demonstrate that DD promotes students’ learning of and improves their feelings about biology. Presenting the course content within the framework of current, science-related policy issues resulted in significant gains in students’ knowledge, as measured by performance on semester exams and the pre-/post-course content assessment, as well as in students’ perceptions of biology, as measured by the pre-/post-course self-assessment of feelings toward biology. These findings are consistent with Weasel and Finkel, who have reported a similar redesign to nonmajors biology (23). The study reported here provides additional support for this new pedagogical technique by comparing DD with established techniques. According to all of the metrics that were analyzed, DD was found to be superior to both the traditional lecture and the mixed-format courses used in this study. However, further work is necessary to determine how specific active-learning formats compare with DD.

Studies of student motivation reveal that linking course content to personally relevant goals, activating students’ emotions, encouraging student ownership of learning, and fostering social interaction are four key components to enhance motivation of learning (1, 8, 16). DD, as described in this study, possesses each of these components. First, DD uses current events to demonstrate the impact of the material on students’ lives (10). This effect is demonstrated by the gains in students’ self-reported perception of biology’s relevance for their everyday lives. Second, DD activates students’ emotions by using subjective and unre-

![Figure 3](image)

**FIGURE 3.** Effects of course format on student performance. The average scores on the unit exams administered during both versions of the course are shown. *p < 0.02 when comparing exam scores from the course redesign with the old course design.

![Figure 4](image)

**FIGURE 4.** Effects of course format on content mastery. A) The average score on a standardized content exam by students enrolled in different course formats taught by different professors. *p = 0.002 when comparing students in the redesigned course with the traditional lecture course. **p = 0.04 when comparing students in the redesigned course with the mixed-format course. B) Fold change in performance on the content exam when comparing student responses at the end of the semester and the beginning of the semester, where 1 = no change, and > 1 = improvement. Bars for “overall” indicate student performance on entire content exam. Remaining bars indicate student performance on questions grouped by instructional unit. Each question’s unit relationship is listed in italics in Appendix 3.
solved questions, which free students from a fear of failure and allow them to engage more fully with the content (17). This is evidenced by the dramatic improvement in students' self-reporting of their positive feelings about biology, especially when compared with traditional pedagogical formats. Third, DD elicits students' ownership of learning by requiring that students seek information on their own, then present and defend their ideas within their groups and to the class (21). Despite students having to do more work on their own in the DD format, they performed better on exams and the common content exam when compared with students enrolled in courses using a different format. Finally, by allowing students to work in groups, DD promotes social interaction among participants, which greatly improves class dynamics and is fundamental for active discussion to enhance learning (13, 14).

While this study did not directly measure DD's effects on student satisfaction, motivation, or confidence,
the results of the pre-/post-course survey of students' self-reported attitudes toward biology suggest that this pedagogical approach may be beneficial for improving these affective measures. Students enrolled in the DD course experienced significant gains in self-reported understanding of biology-related topics, more so than students enrolled in the mixed-format course. These gains are consistent with the students' actual knowledge gains. For example, students in the DD course self-reported higher gains in understanding of topics related to human development and evolution when compared with ecology. These students also performed better on the semester exams and the content survey questions related to human development and evolution when compared with ecology. However, the gains in self-reported knowledge were much more pronounced than the gain in actual knowledge. Consistent with this observation, a meta-analysis of self-assessment studies showed that self-assessments demonstrate only a weak association with actual learning (20). Interestingly though, this same study demonstrated a much stronger correlation between knowledge self-assessment and affective measures such as motivation and satisfaction (20). Future studies of DD as a pedagogical tool in biology are needed to specifically measure students' motivation, satisfaction, and confidence in order to determine whether this approach is, in fact, effective for enhancing student affect.

Although DD proved to be effective overall, the data suggest that it may be more beneficial for teaching certain biological principles. In this study, the use of DD promoted significant gains in real and perceived knowledge of human development and evolution but not ecology, suggesting that DD may not be effective for teaching ecology. However, there are several additional factors that could also be influencing student performance in the ecology unit. Namely, the ecology unit was the last unit of the semester. Typically, by the end of the semester, student motivation and performance change, which may suggest a need for changing pedagogical strategies (18). Additionally, each instructor assessed in this study has a background in cell biology, which is more closely related to the other instructional units of the course than it is to ecology. Instructor background influences teaching quality and is known to impact student performance (6). To more adequately determine the potential topical constraints of this technique, the order of instructional units will be reversed in future sections of the course and a section taught by an instructor with formal training in ecology will also be assessed.

Whether topical constraints exist or not, it was interesting to see that a particular concept does not need to be directly linked to a DD exercise in order for benefits to be seen. For instance, the topic with the largest gain in self-reported understanding—genome sequencing—did not directly relate to any of the DD exercises in either of the semesters. On the other hand, GMOs were the topic of DD exercises in both of the semesters that the course redesign was taught, yet this concept saw the smallest gains in self-reported understanding. Climate change, vaccinations, and genetic testing each saw larger gains than GMOs in self-reported understanding even though they were only covered directly by a DD exercise one of the two semesters. These observations suggest that DD motivates students with regard to the subject as a whole and not merely the policy question presented by the exercise.

While I believe that DD has broad utility and shows promise across the sciences, instructors should give careful consideration to how they might implement it in their courses. Effective implementation requires significant preparation, detailed attention to current events, and a deep understanding of the student population. The topics used for DD exercises should be ones with which students are familiar, so it is important to know where they get their news. It is also important to know students' prior experiences inside and outside the classroom, as this can influence their receptiveness to a new teaching style (22). Knowing students' backgrounds and preferences can also be useful for generating deliberation groups to optimize diversity while enhancing students' likelihood of success. Much of this can be accomplished by having students complete a demographics questionnaire at the beginning of the semester.

Working through the difficult logistics of course preparation is well worth the effort when one considers how promising this technique is for improving student outcomes. I believe the strongest testament to DD's effectiveness comes from the comparison of student performance on the general education assessment between different course formats. The questions on this assessment were written and agreed upon by each of the instructors teaching the course. The questions relate to the key biological principles that all instructors of the course are expected to teach. All the instructors have the questions from the beginning of the semester and are therefore aware that their students are expected to know these particular concepts. In previous years, there has been very little variation from instructor to instructor with regard to student performance on the general education assessment. However, the results presented here demonstrate a marked increase in performance by students who completed the redesigned course. This indicates that, even though less class time is used to directly teach biological concepts in the DD format, students are gaining more of the desired factual knowledge.

Another reason that instructors should be encouraged to pursue use of DD is its potential to impact extracurricular learning and develop students as critical thinkers and educated citizens. A 2012 report described civic involvement in the United States as "anemic." In 2007, the United States ranked in the bottom fifth of democratic nations for voter participation, yet we consider ourselves the world's leading democracy; additionally, the majority of college students surveyed failed tests on civic literacy (15). As science professors, our primary goal is to create a scientifically literate...
and it is imperative that we demonstrate the relevance of scientific literacy to our nonscience majors. While scientific literacy clearly has social impacts, particularly with regard to human health, the impact of scientific literacy on civic engagement is also important. The use of DD within the science classroom improves scientific literacy while also modeling civic engagement, promoting collaboration, engaging students in diverse ideas, and cultivating a culture of respect, all of which could serve as a nutrient boost for our country’s anemic civic health.

SUPPLEMENTAL MATERIALS

Appendix 1: Policy introduction worksheet
Appendix 2: Final policy worksheet
Appendix 3: Assessment survey
Appendix 4: Demographics of student cohorts
Appendix 5: Graph of topic importance

ACKNOWLEDGMENTS

The author declares that there are no conflicts of interest.

REFERENCES