Using Small Group Debates to Actively Engage Students in an Introductory Microbiology Course†

Joyce A. Shaw, DPT
Endicott College, Beverly, MA 01915

Debates stimulate critical thinking and can be a highly effective way to actively engage students in the classroom. This paper describes a small group debate format in which groups of four to six students debated preassigned topics in microbiology in front of the rest of the class. Rapid advancements in science, especially in microbiology, provide the scaffolding for students to locate and share evidence-based information from a plethora of complex and often conflicting sources. Student-generated debate presentations can be a welcome respite from the lecture format. Debates were scheduled throughout the course to coincide with topics being covered. Questionnaires distributed immediately after each debate revealed that the debates were well received by students and were effective in changing student attitudes and misconceptions. Debate preparation provided students the opportunity to gain proficiency in accessing information from electronic databases, to use resources from professional organizations, and to synthesize and analyze information. In addition, the debate process gave students experience in developing oral communication skills.

INTRODUCTION

Debates are commonly used in academic fields such as history, law, and literature as a way for students to discuss different points of view on a topic, but they have been used less often in sciences (2, 11). Early debates focused on philosophical and theological topics (14). As a teaching pedagogy, the fields of law, history, and literature have traditionally offered many topics on which to debate. Recently, emerging scientific technologies such as cell and molecular biotechnology have changed the way that students think about science (1). Bringing current scientific issues into the classroom helps students relate science to everyday problems and use scientific evidence to critically assess societal challenges. Debates provide the scaffolding for evaluating relevant issues.

The use of debate provides students with an opportunity to develop critical thinking skills (3, 4, 5, 6). The thinking starts with the preparation students must do before the debate. Through reading and research the students extract pertinent information and analyze which ideas support their assigned position. The ideas are then synthesized into formidable arguments. For effectiveness during the debate, the ideas must be pertinent and succinct.

During the debate, students use verbal communication and organizational skills. To convince the audience, they must rely on a well-planned analysis of the arguments that support and refute their point of view. Carroll and colleagues (3) have documented that students developed oral communication and argumentation skills using small group debates in an undergraduate natural resources policy class. Radford University developed and implemented a multidisciplinary oral communication program using a debate format that demonstrated significant improvement in students’ oral communication skills (4).

Debate is superior to other teaching methods in helping students to develop their own viewpoints (5). Students are asked to analyze positions that may or may not be those with which they are comfortable. The students present opposing sides of an issue without teacher bias. Each side of the debate is seen as credible and legitimate (5). Students can argue a position without fear of exposing personal viewpoints in front of their peers. Debate provides a unique opportunity for students to come out of their comfort zone to try positions that they may not have otherwise entertained and to change their opinions.

A small group format for debates gives each debater an active role (2, 3). Students were randomly placed into groups of only two or three students on each team, resulting in four to six student debaters for each topic. (With only two or three members per team, there was a greater chance that all team members would be actively involved.) The remainder of the students made up the audience of listeners. Studies have found that when whole-class debates occur, more reserved students are less likely to actively participate (11). Other considerations were the tendency for males to be more comfortable than females in adversarial environments and the preference of some cultural groups for harmony over open opposition (14).
The small group debates resemble a fishbowl discussion, in which students sit in a circle within a circle or a center-stage formation. When debates are set up in this manner, students who form the audience benefit from critically evaluating the debaters on content, involvement, language, and speech (10). Fishbowl discussions used in the field of psychology have demonstrated positive learning opportunities for students (8).

The debate format has been criticized for oversimplifying complex issues into dichotomous options (14). The use of small groups debating in front of the rest of the class allows for diverse evaluation of the issues by the student listeners, who are observing the debaters. The students who are listening are less focused on winning or losing the debate and can offer critical evaluation of the arguments presented. During the classroom discussion following the debate students may assess the ambiguity and complexity of the issues, in addition to judging who won or lost the debate.

A small group debate activity is an effective teaching pedagogy with many desirable outcomes. Debates help students develop discussion and listening skills, (7, 10) promote active learning (3, 12), and improve critical thinking skills (5, 10). Small group debates are simple to implement, well received and enjoyed by students (2, 4), and are of benefit to both debating students and listeners (7, 10).

**Intended audience**

This activity was done with sophomore nursing students in an introductory microbiology course. It is intended to be used as a classroom activity in a biology or microbiology course. While this activity could be used with any level of undergraduate students, some freshman students may not have the necessary critical thinking and library skills to prepare meaningful arguments for debates. Debate activities in introductory courses, while requiring more teacher preparation, offer opportunities for students to critically assess both sides of scientific issues at a point in their education when they may not have already formed strong opinions on the topics prior to these debates. Upper-level students can also benefit from this activity, but may be less open to new ideas.

**Prerequisite student knowledge**

Students need a basic understanding of fundamental terminology to research, evaluate, and understand arguments. Allied health and science majors may already have acquired these skills through prerequisite courses such as General Biology, Anatomy and Physiology, and freshman seminars. My students were familiar with using library databases to search professional literature, but assistance with references could be provided for students who are not familiar with college-level research. Students don’t need to be experts on the subject matter or to have prior debate experience to succeed with this curriculum activity (13). Students can be reminded that they engage in debate processes in all areas of their lives whenever they express their opinions or persuade others to make decisions in their favor (13). Specifically, students should be able to: explain controversies surrounding subject matter in microbiology; to analyze relevant material and defend positions on current issues in microbiology (even when the position differs from their own) based on factual arguments; to collaborate with and in opposition to peers in preparing to present an organized debate; and to orally communicate controversial ideas in a convincing manner.

**Learning objectives**

At the completion of this activity, each student will be able to:

1. In collaboration with peers, design and orally present a debate position concerning a controversy in microbiology.
2. Formulate an opinion about controversies in microbiology based on an active learning activity.

Appendix 1 lists the learning objectives with corresponding evidence and a summary of the outcomes.

**PROCEDURE**

**Learning time and preparation**

The design was intended to extend the debates over the course of one semester, with single debates taking 30 to 50 minutes of class time. No debates were scheduled during the first month of class, to allow students time to prepare arguments and rebuttals for the first debates. Class time varied depending on the length of class discussion following the debate presentation. A debate was scheduled approximately once every two to three weeks to coincide with lecture topics. The debates used parts of seven class periods over the semester and counted for ten percent of the course grade.

Activity 1 (week 1 or 2 of class): Selection of debate topics, introduction to the assignment, distribution of instructions, and sample reference lists.

Activity 2 (week 4): Debate on viruses: are viruses alive?

Activity 3 (week 5 or 6): Debate on the benefits versus risks of genetic engineering.

Activity 4 (week 7 or 8): Debate on the benefits versus risks of using antibacterial compounds in household products.

Activity 5 (week 9 or 10): Debate on the advantages versus disadvantages of mandatory blood testing for pathogens for all newly admitted hospital patients to control infection rates.

Activity 6 (week 11 or 12): Debate on the benefits versus risks of mandatory early childhood immunizations.
Activity 7 (week 13 or 14): Debate on the benefits versus risks of requiring all students to be immunized against human papilloma virus (HPV) and meningococcal disease.

Instructor preparation started with identifying appropriate topics, sample references, dates for each debate, and dividing students into teams (Appendix 2). Topic assignments were random, so some students found themselves assigned debate positions that they did not necessarily agree with. Along with the students’ names, the sign-up sheets also contained suggestions for references. Although provision of suggested references reduces the student’s responsibility for conducting research, it may be necessary for students who are in introductory courses or who have little research experience. Sample articles can also help focus students on what position they should take toward a debate resolution (9). Teacher-guided topics may also help fit the debate into a shorter amount of class time (13). In addition to consulting the listed references, students were expected to identify and utilize additional evidence-based research to support their arguments on the topics under debate.

Next, a handout was distributed and discussed, containing the learning objectives and assignment instructions (Appendix 3) and a copy of the grading rubric (Appendix 4). After the debate the instructor distributed a questionnaire (Table 1) to all students. The questionnaire was to gather students’ opinions regarding the value of the activity as a learning experience, to provide an opportunity for students to reflect on what they learned about the subject under debate, and to evaluate whether or not students changed their opinions. Debaters had the opportunity to reflect on how well their team members had worked together to complete their preparations.

Instructors who are not familiar with the debate process will find a wealth of information on web sources such as the University of Vermont’s Debate Central and the publications of the International Debate Education Association (13).

Materials

The classroom was organized so that the two teams were standing on opposite sides at the front of the room where they were visible to the rest of the class. Most teams used PowerPoint presentations to add graphics and to bullet-emphasize major points. A computer with projection capability was needed for PowerPoint presentations. No additional materials were required.

Safety issues

As a classroom activity, there were no major safety concerns with this activity.

Debate procedure

Each debate took place during 30 to 45 minutes of one class period. Instructions given to students are presented in Appendix 3. During the first round, both groups of debating students were allowed ten minutes each to present their points of view. The activity started with the affirmative position. The debating students on the affirmative side were asked to define terms, to support the main case, and to summarize major points. Next, the negative side was given ten minutes to present its opposing arguments, during which they could refute definitions, outline the opposing case, and summarize the opposing point of view. The second set of speeches followed the same order with a five minute time frame for presentation of constructive arguments. The formal debate concluded with five-minute rebuttals. Class discussion followed. The instructor used a grading rubric (Appendix 4) during the debate to score each team. Sample student PowerPoint presentations for two debates are presented in Appendix 5, 6, 7, and 8.

Table 1.
Post debate questionnaire.

| Name: Are you a debater or nondebater? (circle one) |
| Debate topic: |
| 1. How did you feel about this topic before the debate? Mark the box under the description that best matches your point of view. |
| 2. How do you feel about this topic after hearing the debate? Mark the box under the description that best matches your point of view. |
| 3. Please rate how you feel about this statement. “This debate improved my understanding of this topic.” |
| 4. List three things that you learned from this debate. |
| For debate teams only: Please reflect on the overall participation and contribution of the members of your team. |
Following the debate, a questionnaire (Table 1) was distributed that asked each student to rate the value of the debate as a learning experience and to disclose whether the student changed his or her opinion on the topic under debate. Debaters were also asked to reflect on the contribution made by each team member. The instructor later spoke individually with each student on those teams on which some students expressed concerns that the work was not equally divided. In rare cases, where all students agreed that one or more team members did not make significant efforts to contribute, an individual's grade was lowered by 10 to 20 percent. In most cases, however, all team members received the same grade for this activity.

**DISCUSSION**

**Field testing**

The debate activity was field-tested over four semesters by the same instructor in four introductory microbiology classes of 26 to 30 students. Debate topics varied, but all four classes did debates on viruses, genetic engineering, antibacterial compounds in household products, and the use of early childhood immunizations. Data was collected for these debates from a total of 97 students.

According to the student questionnaires (Table 1) that were completed immediately after each debate, 97% to 100% of students agreed or strongly agreed that the debate improved their understanding of the topic (Table 2). Comments on the questionnaires indicate that students enjoyed watching their classmates argue topics that were relevant to the units they were beginning to study at that time in the course. While the debates could be scheduled before or after the instructor presented the topics in class, the benefits of planning debates while the material was still new to the students appeared to allow them to form their own opinions on the topics. The brevity (five to ten minutes) of the debaters’ arguments tended to hold the listeners’ interest and to keep the class engaged in the topic. After the debate, by a show of hands, the listeners informally rated the debaters on which team was the more convincing. After some debates, the listeners thought that the side with the least popular view did the best job of defending its position. This gave students the opportunity to reflect that strong arguments can be made for unpopular positions.

Debate proved a useful tool for opening students’ minds to change. As educators we want students to be open to change and to formulate their own opinions. We are often encumbered by the preconceived notions that our students acquire before taking our classes and by instructor bias. A positive result of the debates was that a large percentage (25% to 79%) of students changed their mind after listening to the debates (Table 2).

There was wide variability (55% to 79%) in whether the debaters agreed with the position they were assigned (Table 2). Students arguing for positions for which they disagreed served as role models for situations when health care professions are obligated to support patients’ decisions even when they may not agree with the choices the patients have made.

**Evidence of student learning**

Each student was assessed for their debate using the grading rubric (Appendix 4). The correlation between the student debate grades and overall course grades was 83%, with the debate grade being the higher of the two grades. This indicates that most students took the debate assignment seriously and put in their usual effort or more. It is possible that some students who did not usually perform well in the class might have received debate grades that were higher than their normal grades because of their group’s collaborative efforts.

The values on the grading rubrics indicates that the highest level of competence achieved for the learning objectives was for explaining the controversies surrounding the subject matter. The high grades on the grading rubric

<table>
<thead>
<tr>
<th>Debate Topic</th>
<th>Number of Students</th>
<th>Percentage of students who changed their opinion – before vs. after the debate</th>
<th>Percentage of debaters who agreed with the random position assigned.</th>
<th>Percentage of students who agreed or strongly agreed that “This debate improved my understanding of the topic.”</th>
</tr>
</thead>
<tbody>
<tr>
<td>Genetic Engineering</td>
<td>85</td>
<td>56%</td>
<td>79%</td>
<td>98%</td>
</tr>
<tr>
<td>Viruses – living vs. nonliving</td>
<td>97</td>
<td>79%</td>
<td>68%</td>
<td>97%</td>
</tr>
<tr>
<td>Use of antibacterial compounds in household products</td>
<td>72</td>
<td>53%</td>
<td>64%</td>
<td>99%</td>
</tr>
<tr>
<td>Childhood Immunizations</td>
<td>44</td>
<td>25%</td>
<td>55%</td>
<td>100%</td>
</tr>
</tbody>
</table>
for this objective indicate that students had identified relevant material and were able to explain the controversies using factual information. Also high were grades related to students’ being able to formulate their own opinions. However, some groups were more persuasive and thus did a better job defending their positions than others. There were several reasons for this. While some students gathered adequate amounts of information, they failed to analyze the importance of one argument over another, thereby not devoting adequate time to the most important arguments. Groups that had not spent enough time collaborating also gave presentations that were less convincing. The evidence they presented tended to be formatted as separate facts and not synthesized around one or two central themes. A few groups used arguments that lacked credible scientific evidence. By far the most challenging of the learning objectives was oral communication. Most students had difficulty delivering the debate, often reading from prepared note cards and not making eye contact with the audience.

Students in the audience were active in post-debate discussions. They were anxious to express their opinions after hearing both sides of the issue. Although not every student spoke during the discussions, all appeared anxious to express their opinion with a show of hands. The high percentage (97%–100%) of students who agreed or strongly agreed with the statement “This debate improved my understanding of the topic,” indicates a high level of student participation in preparing, presenting, and listening to small group debates.

Possible modifications

Debates could be used to introduce students to new units of study, with debaters responsible for defining and explaining new terms relating to their debate. This method engages students right away with the relevance of the new topic to current issues, but would not be practical in classes where students do not have strong science backgrounds.

If students need more assistance with research methods, the instructor could provide a sample article along with the list of suggested references that is provided on the sign-up sheets.

Creativity levels among debate teams varied and could create bias in the listeners. Some teams created surveys or activities for the listeners who were the audience. For example, when arguing the need for antibacterial compounds in household products, one team asked the class to rank a list of places in the home where the highest levels of bacteria are commonly found. This activity biased the audience to the degree that 100% of them agreed that there is a need for antimicrobial compounds in household products. It appeared that the more engaging the debate presentation was, the more likely students were to accept those arguments, rather than basing their opinions on the scientific evidence that was presented. In this case, the instructor highlighted some of the opposing team’s arguments so there could be a class discussion based on scientific evidence. However, the instructor supported all students in their opinions. Recognition and understanding of both sides of an argument are skills that are necessary in dealing with patients in the medical field.

The size of the debate teams could be varied to accommodate larger or smaller classes. Also, topics could be changed to relate to relevant course material, as well as to current issues in the subject. Thus, debates are a flexible pedagogy that can be modified to suit the individual instructor and course content.

SUPPLEMENTAL MATERIALS

Appendix 1: Learning objectives, evidence, and outcomes
Appendix 2: Sign up sheets with sample references
Appendix 3: Student Handout: Debate Instructions
Appendix 4: Grading rubric for debates
Appendix 5: Sample student PowerPoint: Debate arguing that viruses are alive
Appendix 6: Sample student PowerPoint: Debate arguing that viruses are not alive
Appendix 7: Sample student PowerPoint: Debate arguing in favor of adding antibacterial agents to household products
Appendix 8: Sample student PowerPoint: Debate arguing against the use of antibacterial agents in household products

ACKNOWLEDGMENTS

This research was partially funded by Endicott College research funds and a Davis Foundation Scholarship of Teaching and Learning grant, also from Endicott College. The author also wishes to acknowledge the Biology Scholars Program (formerly the Scholars in Residence Program) of the American Society for Microbiology for guidance and inspiration in developing the study, and Endicott College biology/biotechnology student Kelsey Panakio for assistance with data collection.

The author declares that there are no conflicts of interest.

REFERENCES


