TIPS, TRICKS & TECHNIQUES

Making the Most of Science Seminars

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Abstract

Although guest speakers have been a part of our curriculum for several decades, in recent years we have adopted a system that allows us to maximize the benefit of these speakers for our students. We provide learning opportunities before, during, and after a seminar to enhance students' scientific comprehension. Our system begins with students reading peer-reviewed literature relevant to a future seminar. In class, students work cooperatively to answer guided questions about the article, which serves as a basis for a discussion of the article among the entire class. This preparation facilitates students' understanding, their engagement, and their awareness of effective presentation techniques. Finally, small-group discussions with the speaker can provide students knowledge about their curriculum, awareness of additional opportunities, and insight into the nature of science. Our system thus provides a series of learning opportunities that ensure student engagement with the material multiple times, resulting in a deeper understanding of scientific research and effective mechanisms to communicate it.

Key Words: *Seminar; research talk; research articles; scientific literacy.*

○ Introduction

Biology programs often include seminar presentations from outside speakers as part of a regular seminar series or as opportunities allow. In a recent survey of biology programs in the Great Lakes area, more than two-thirds of programs include research seminars as part of the curriculum (Parker & Morris, 2016). Research seminars provide students the opportunity to interpret and critically analyze scientific information and help develop their maturity and confidence as they enter the scientific field (Pall, 2000; Hunter et al., 2007). Often departments provide travel funding and/or stipends for these speakers and thus must demonstrate value for their students. At Canisius College, we have attempted to maximize the benefits of our limited travel and speaker funds by developing multiple learning opportunities related to each departmental seminar. Our goal in this article is to share our experience in using a single seminar to teach multiple critical skills related to scientific communication.

○ Increasing Comprehension of Scientific Literature

Preparing Students for Discussion

Prior to each seminar, we required students to read a peer-reviewed paper related to the upcoming seminar. We requested that seminar speakers provide either a paper that they had authored or a paper that was related to their topic. Specifically, we asked that chosen papers have methods, analysis, and results that would be accessible to sophomore-level and junior-level biology majors. Papers were posted to our student learning management software for student accessibility. This also allowed faculty to determine whether students had accessed the paper.

The week prior to an outside speaker, we devoted class time to the seminar-related paper. Students were expected to read the paper prior to coming to class. To verify that all students had prepared for class, we gave a short quiz designed to test broad understanding of the article. For our quizzes we developed multiple-choice questions related to topics that were broadly addressed in the article, but not simply known from prior course work. For example, we tested on primary hypotheses, study species, major techniques described in the methods, key and/or broad results, and occasionally how the results were presented. By using a quiz, students were held responsible for preparing for class; however, we did not want students to spend too much time on comprehension of every detail in the article. Because the quizzes were short, students were concerned that they would miss key details when reading the article or that missing a single question would negatively affect their grade. Therefore, we provided six multiple-choice questions, but students had to correctly answer only five to receive 100%, the maximum score on the quiz.

Article Discussion

Students worked together in groups of three to five, during one or two class periods, to answer a series of questions related to the paper. This active-learning assignment allowed students to apply new knowledge

The American Biology Teacher, Vol. 81, No. 8, pp. 585–588, ISSN 0002-7685, electronic ISSN 1938-4211. DOI: https://doi.org/10.1525/abt.2019.81.8.585.

to what they had previously learned, a particularly effective mechanism of teaching science (Leonard, 2000). This process provided the additional benefits of a cooperative learning environment (for a review, see Lord, 2001). We crafted group assignments to demonstrate comprehension of background material and methods and to evaluate results and supporting data critically. Questions related to the introduction might include defining common terms, correctly ordering a sequence of events, demonstrating connections between general biology knowledge and specifics addressed in the article, and clearly stating specific hypotheses. Students were asked to explain how and/or why specific methods might have been chosen when those methods had been practiced in required labs. When reading ecological papers, students were asked to identify challenges and adjustments needed for the vagaries of fieldwork and to understand and critically evaluate artificial conditions of laboratory experiments.

Much of the time spent on group assignments was devoted to the results section of the paper. Students were asked to dissect figures and tables to demonstrate a clear understanding of the data presented. For figures, this included why a particular figure type was chosen, identifying axes, explaining why one variable was dependent on another, and describing the data that would be expected if the hypothesis was supported. For tables, we might ask why the authors used a table instead of a figure, what was the overall significance of the data presented, or how specific results in a part of the table related to a hypothesis. When figures or tables did not support the original hypothesis, students were asked to provide a hypothesis that was supported by the data. Although we focused on figures and tables, we also asked students to evaluate the importance of some statistical testing by focusing on *P*-values, particularly of simple statistical tests. Students were then asked to determine whether the authors' discussion and conclusions were justified by the data presented.

After the students completed and submitted their group assignments, the whole class discussed the answers to the questions to ensure comprehension. Individual groups were expected to take the lead in answering at least one question. However, all groups were encouraged to confirm and/or elaborate on the lead group's answers. Students benefited from the cooperative learning environment, in which they modeled teamwork, served as peer instructors, and were comfortable presenting a group answer to questions. Each student received the same grade for their group's work, which was averaged with the quiz grade to determine a student's final score for the article.

○ Increasing Student Engagement in Seminars

Understanding the Seminar

Our process provided students the opportunity to better comprehend scientific seminars. Because they had read and discussed a relevant paper, students reported being more engaged in seminar material and understanding how the topic connects to a broader biological context. Hearing about the topic for a second time helped students understand the approach to the topic, follow the types of methods used, and even develop a familiarity with the way results may be presented. When students had not participated in seminar discussions (either before we implemented this system or because they were absent), they often commented about the difficulty of following a seminar, especially with complicated methods and/or multiple results.

Student Participation

The process of science involves critically analyzing scientific material, asking questions that arise, and engaging in energetic discussion around a specific topic. Historically, students have expressed discomfort with asking questions at the end of seminars because they were afraid they would appear inattentive, disrespectful, or even uninformed. Our process addressed each of these concerns because the faculty both taught and modeled appropriate questions. We taught students a variety of opening phrases (e.g., "I may have missed this but . . . ," "Could you clarify . . . ," and "Could you review . . . ") to reduce the pressure of appearing inattentive. Prior to the first seminar, we discussed how scientists use peer review, including questions during seminars, to refine both the research and its presentation, and explain that questions attempt to improve science, not to disrespect the work presented. Finally, because our students had already read and discussed related papers, they were more comfortable asking questions and their questions were generally more complex, often combining the background of the initial paper with specifics that they learned in the seminar. Thus, our preparation resulted in strong student participation during the question-and-answer session at the end of seminar presentations. Prior to this system, we had few or no students asking questions at the end of a seminar, but with this preparation students generally ask more than half of the questions at the end of seminars. In fact, because we generally ask faculty to hold their questions until after students have the opportunity to speak, on more than one occasion students have asked all the questions following a seminar.

Critiquing the Presentations

Effective seminar presentations combine solid science with an engaging speaking style, effective audiovisual aids, and an organized and coherent outline. We used a score sheet to evaluate all aspects of the presentation, to have students deconstruct a seminar to determine whether it was effective. An additional benefit of our process was familiarizing students with expectations for their future presentations, because the same sheet is used to score student seminar presentations required in our curriculum. Our evaluation covers background information, results, conclusion, organization, visual aids, and overall professionalism (Figure 1). For each of these areas, we have specific evaluative questions as well as opportunities to provide comments and critiques. At Canisius we use the terms *warm comment* and *cool comment* to get away from "pros" and "cons" or "positive" and "negative" comments, because previous groups of students felt unqualified to critique a scientist or were uncomfortable with negative feedback about their peers. We also discussed the seminar in class following the presentation, which allowed students to calibrate their expectations in relation to those of the faculty and their peers.

○ Informal Discussions Can Provide Additional Benefits

After a seminar, we invited students to meet with the speaker for an informal discussion. Students could use this time to ask additional questions about the seminar and how it related to the field, but they could also benefit from information unrelated to the seminar itself. The nature of the discussion varied depending on the specific speaker. Our speakers could be divided into four broad categories: alumni;

Evaluator's name :_____ Speaker:_____

Time start: _____ Time end:_____ (not including questions):
Write one question for the speaker.

Biology Seminar Speaker Evaluation (Total score: /100 points

	1. **Background info: (/ 20)**
	Did the speaker provide enough background information for you to understand the research? **(5 pts)**
	Is the hypothesis clearly stated and the rationale for the hypothesis discussed? **(5 pts)**
	Did the speaker provide information on why this research is important and how it contributes to the specific field of biology**? (5 pts)**
	Did the presenter explain how the research related to transfer of information? (**5 pts)**

Warm comment:
Cool comment:

	2. Presentation Results (/15)
	Did the presenter state the specific question addressed in each data slide? Did the speaker explain the rationale for each experiment? **(5 pts)**
	Did the speaker explain how the experimental design allowed the researchers to address the research question? **(5 pts)**
	How well did the speakers explain the results of each experiment (i.e., did you understand the meaning of the figures/tables presented, did you understand the controls in the experiments?) **(5 pts)**

Warm comment:
Cool comment:

	3. Evaluation and Conclusion (/15)
	Did the presenter effectively summarize the results and explain the significance of the results relative to the hypothesis? **(5 pts)**
	Did the speaker critically evaluate the research (i.e., Give an example of how the research could be improved?) **(5 pts)**
	Did the speaker suggest appropriate future directions of the research?**(5 pts)**

Warm comment:
Cool comment:

	4. Organization (/10)
	Did the speaker present the material in an organized and logical sequence? **(5pts)**
	Did the speaker use transitions between slides? Did the presentation flow? **(5 pts)**

Warm comment:
Cool comment:

	5. Visual Aids (/20)
	Are slides clear, concise, and neat? (i.e., Appropriate titles for each slide? Text kept text to a minimum by avoiding jargon, using active voice)**(10 pts)**
	How well could you see the text and figures on the slides? Was the text font large enough? (min 28 pt for text). Were the figures at high enough resolution? Were background colors and text colors effective? **(10 pts)**

Warm comment:
Cool comment:

	5. Professionalism (/20)
	Did speaker maintain good eye contact with the audience?**(5 pts)**
	Did the speaker present material enthusiastically? Did the speaker use the pointer effectively during the presentation? **(5 pts)**
	Did the speaker demonstrate satisfactory knowledge of the subject? Did the speaker respond satisfactorily to questions? **(5 pts)**
	Is the presentation well-rehearsed? (**5 pts)**

Warm comment:
Cool comment:

Figure 1. Score sheet used to evaluate speakers, both guest speakers in our seminar series and student speakers in departmental presentations.

applicants for our biology faculty positions; faculty recruiting for graduate programs at other universities; and other biologists, including medical researchers, industry professionals, and other academics. Discussions with alumni provided a perspective on the curriculum and faculty at Canisius, which they share with current students. Post-seminar discussions between students and potential department faculty were part of the hiring process because our students help evaluate the fit of a possible faculty member by evaluating the applicant as both a potential teacher and a research mentor. Additionally, these discussions provided applicants with information about the expectations of student–faculty interactions. Faculty at other universities who were looking to recruit graduate students could use post-seminar discussions to provide general information about, student expectations in, and advice on preparation and application to their graduate program(s). Other speakers might include colleagues at other institutions, collaborators, or researchers of general interest whose discussions

could provide students the opportunity to gain a different perspective regarding topics and research expertise that differs from members of our faculty. These latter two groups provide additional information about different scientific disciplines, which may be useful in career counseling, an important part of undergraduate biology education (Araneo et al., 2017).

How This Method Is Used at Canisius College

The method described here can be used in many circumstances within a program's curriculum. At Canisius we have used the method for a single seminar speaker, for a class that includes outside seminar speakers, and for a seminar class that includes student presentations. We have used the method for course guest lecturers in both required and elective courses; for our required sophomore seminar in which all majors are taught a variety of skills, including reading papers and listening to seminars (we usually have two outside seminars); and for our senior seminar, which begins with two outside speakers followed by students giving two presentations each and being graded by both students and faculty (using the same score sheet they used in both the sophomore and senior seminars). When possible, we scheduled research presentations by candidates for faculty positions to occur during our seminar classes, providing both a known group of students to attend the seminar and an opportunity for our students to have meaningful input into hiring decisions by comparing candidates. Because we have used this approach in several parts of our curriculum, we have used the method with groups as small as 12–15 students (a single course) or as large as 80 students (all sophomores). An additional benefit of our system has been that because we used the same score sheet for all seminars, including student seminars, we were able to talk about how expectations can vary at different points in a scientist's career. When the score sheet was used to evaluate student presentations, the faculty provided students with summarized feedback from their peers rather than the individual score sheets, which ensured that students received feedback that was not overly critical, inappropriate, or wrong. By using this method to get more from seminars in our department, we feel we are helping our students transition from biology students to biologists.

Conclusion

Departmental seminars provide the opportunity to learn from scientists outside of the faculty or to be exposed to expertise beyond what the faculty can cover in the classroom. Our method provides multiple additional benefits from a single seminar speaker. First, by requiring students to read papers related to the seminar, students both practice interpreting a scientific paper and gain a greater understanding of the process of science. When students are focused too much on understanding details in a paper or seminar, they often miss the big picture. Alternatively, some students focus on the big picture but not on why particular methods were chosen or why specific experiments were performed. Because they have seen the material twice, students can develop a deeper understanding of the details and the broader context of the seminar. Second, students can use this deeper understanding to better critique the quality of a seminar. This newfound knowledge of effective seminar strategies can be used to improve students' future oral presentations. Third, students can get a different perspective about career options in the field of biology and/or exposure to new scientific fields. This may help graduating students navigate postgraduate programs and job-market options, as biology-related careers are projected to increase over the next decade (Araneo et al., 2017). An additional benefit of our system is that we provide our alumni who are completing degrees an audience for their seminars. Our alumni can use a receptive audience to provide feedback from both students and faculty as they prepare for a thesis seminar or job talk. Thus, our system produces multiple benefits for our faculty, students, and guest speakers by maximizing the engagement and learning opportunities around a single seminar.

Acknowledgments

We thank the Canisius Biology Department for funding the seminars and experimenting with different ways to engage students. We also thank the Canisius College Science Scholars who were involved in initial plans to develop this project. We are particularly grateful to Dr. Elizabeth Hansen, Dr. Aronica's wife, who facilitated the completion of this manuscript after Dr. Aronica's death. This material is based on work supported by the National Science Foundation (grant nos. 0965933 and 1643649). Any opinions, findings, and conclusions or recommendations expressed in this material are those of the authors and do not necessarily reflect the views of the National Science Foundation.

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