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Practicing Critical Thinking in Undergraduate Microbiology Classes by Presenting News Stories with Data Evidence

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INTRODUCTION

A key aim of undergraduate education is to train scientific literacy – the ability to evaluate the quality of scientific evidence and apply it in real-world situations (1). To this end, students are often asked to read original research articles in college classes, but original research papers often include information that is not easily accessible to students due to technical details, terminology, or a multitude of new concepts introduced at once. In addition, students are often more comfortable or used to paraphrasing the conclusions the authors stated in the text than viewing and critically evaluating the data evidence from which the conclusions arose. Yet competence in drawing conclusions from data evidence is at the core of understanding how scientific knowledge is created (2) and among the fundamental skills in a microbiology curriculum (3).

As an approach to accessing the data in scientific literature, news stories can help generate initial excitement and interest, while highlighting the importance and currency of the work. The aims of the approach described here are to train scientific literacy by having students access new microbiology research through news stories and practice critical evaluation of the data evidence. The students (i) take an active role by choosing a recent (12 months or newer) news story on a microbial topic; (ii) read the original peer-reviewed article the story was based upon; and (iii) give a short (5 to 10 min) oral presentation of the key findings to the class, while explaining how the data the scientists generated resulted in some of the key conclusions reported in the news (Table 1).

The approach presented here emphasizes student learning with data observation from original, recent, and transformative research, while promoting critical thinking, all while letting students participate in creating the learning environment (4, 5). Another learning objective is the opportunity to reinforce students' understanding of the difference between peer-reviewed scientific literature versus non-peer-reviewed literature written by nonspecialists. Such focus on differentiating the content of primary literature and a news article is key in introductory nonmajor and core competence science courses training information literacy (6, 7). For advanced science majors, news stories provide an opportunity to reinforce science process skills through a focus on data interpretation (2, 3, 7). Here, the key expectations are as follows: (i) demonstrating the link between the evidence and conclusions and (ii) understanding some of the caveats or limitations of the data. In addition, if the students notice significant biases in reporting between the news story and the original article, a discussion of such observations is also encouraged.

The described approach is best suited for advanced science majors in upper division undergraduate classes and lab sections or in graduate classes. It could be implemented in classes in either face-to-face, hybrid, or online settings. It has been tested during in-person classrooms in past years and was successfully implemented during a synchronous online class during the past academic year impacted by COVID-19. The described module was used in an upper division marine microbiology class but could easily be implemented in a biology class with another focus area.

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PROCEDURE

The instructor presents the expectations for the assignment during the first class meeting. The instructor demonstrates an example of an assignment, showing a sample news story, and highlights key data from the original paper that were needed to draw the key conclusions in the article

TABLE 1
Project overview

Assignment stage	Key objectives
Find the news story	• Generate excitement • Identify a recent high-impact research finding • Make connections to previously learned concepts • Introduce new concepts
Read the peer-reviewed article	• Differentiate types of published literature (peer-reviewed vs. non-peer-reviewed) • Reinforce previously learned concepts • Identify data that resulted in conclusions stated in the narrative • Deepen the understanding of new concepts • Learn some of the limitations of the conclusions, given the data
Present the research findings with data evidence	• Demonstrate understanding of how the data resulted in the conclusions • Discuss some of the limitations of the data • Contribute to creating and delivering the class learning objectives

and the news story. The students then sign up for the date of their presentation using a Web-based tool, such as a Wiki within Blackboard (Table 2). When the students find a news story, they post their topic, the link to the news story, and a link to the original journal article cited in the news story. The students are given sample websites for science news and sites where they can look for press releases, such as the sites of major funding agencies and universities. The students may also use podcast, social media, or any other news forms as the source for the news story, which should be <12 months old.

The students are expected to then find and read the original journal article that the news story was based upon and to prepare a class presentation. The key expectation is that the students will show data (figures, tables, or any other data form) from the original research article and explain with the data evidence some of the key findings that were discussed in the news story. The students are also expected to discuss the limitations of the study. The students are encouraged to include a brief introduction to the topic but are asked to minimize the number of slides with bullet points not tied to any data evidence presented. One student presents per class period, if possible, depending on the class size and meeting frequency. The entire expected presentation length in the classes I've taught has been approximately 10 min, but it could be shorter depending on the class size.

The class presentations are ideally distributed throughout the semester, which allows repeated reinforcement of the learning objectives (Table 1). After each presentation, the instructor prompts questions from the class and asks questions of the student, drawing out more discussion on the topic. In my experience, this postpresentation discussion is usually fruitful in drawing additional points and discussion from the presenter. To close each presentation, the instructor emphasizes and revisits the class learning objectives in the context of the new research presented (Table 3).

Safety issues

No safety issues are identified.

CONCLUSION

Alternate and active learning approaches are increasingly changing the learning landscape in college biology classrooms. Active learning can take many forms, and many lines of evidence show that it improves learning outcomes (3, 4, 8). Having students take charge of their learning by independently choosing the research articles from popular news can be considered a mode of active learning and moves the learning environment from teacher-centered to student-centered, which has repeatedly been shown to improve learning outcomes (4, 5).

TABLE 2
A sign-up table that the instructor will post in a Wiki that is shared with the class[a]

Date	Student name	Topic	News story link	Original article link

[a]The instructor prefills the dates made available for student presentations. The students fill in the rest through the semester. A separate link is made available for presentation slide submissions.

TABLE 3
Examples of news stories that were chosen, retrieved, and presented by students during the spring semester, 2021

News story	Original article	Topic	Concepts discussed, introduced, or revisited with class
https://www.cnn.com/2021/03/16/world/international-space-station-microbes-scn-trnd/index.html	(9)	Novel bacterium isolated from the International Space Station	• Methylotrophy • Phylogenetic tools • Evolution • Extreme environments
https://www.mpg.de/16524858/new-form-of-symbiosis-discovered	(10)	New denitrifying symbiont discovered	• Symbiosis • Genome erosion • Nitrogen cycle
https://www.the-scientist.com/notebook/microbes-find-their-niche-in-underwater-shipwrecks-68095	(11)	Iron oxidizing shipwreck microbiome	• 16S rRNA gene as a microbiome analysis tool • Energy metabolism • Iron oxidation
https://www.sciencedaily.com/releases/2020/09/200925113346.htm	(12)	Bacterial patch foraging	• Resource limitation • Bacterial growth • Chemotaxis, motility • Patchiness

The approach trains students' scientific process skills by emphasizing the fundamental importance of data evidence in generating scientific knowledge. Students are expected to show an understanding of this concept by presenting data with conclusions and not simply paraphrasing authors' statements. The expectation of making a presentation to their peers in the classroom sets an additional bar for the students to adhere to. It is expected that students will have trouble understanding some of details in the primary literature, which gives the instructor an opportunity to gauge the difficult points and to explain unknown concepts. The approach reinforces through the semester the importance of viewing and assessing the data in the primary source when learning about new research via news. At the same time, the new research presented adds novelty to the class content from year to year.

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I declare no conflict of interest.

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