Analysis of a COVID-19 Clinical Trial to Emphasize Experimental Design and Quantitative Reasoning in an Introductory Biology Course†

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Increasing student exposure to primary literature in early biology coursework can enhance scientific literacy and quantitative reasoning skills. The efficacy of primary literature discussion is heavily impacted by article selection, as student engagement is optimal with material that is topical and has clear relevance to real world issues. During the COVID-19 pandemic, the prevalence of COVID-19–related scientific research in the mainstream media makes it an ideal topic for current discussion in entry-level biology courses. Here, we present an activity developed to facilitate a remote, synchronous discussion of an open access clinical trial publication on the experimental drug remdesivir in the treatment of COVID-19 (Beigel et al., 2020, N Engl J Med https://doi.org/10.1056/nejmoa2007764). The activity, which is amenable to adaptation for other research articles, emphasizes concepts in experimental design, statistical analysis, graphical interpretation, and the structure, content, and organization of typical sections of a primary research article. Importantly, the activity highlights the utility of the classroom response tool Pear Deck, a Google Slides add-on, for creating engaging literature discussions that can be readily adapted to a wide variety of teaching modalities.

INTRODUCTION

The COVID-19 pandemic has presented a unique opportunity to engage entry-level biology students in discussion of research at the forefront of daily news. Literature analysis is an effective tool for enhancing quantitative and scientific literacy (interpreting, evaluating, and contextualizing data) in undergraduate biology curricula (1–3). Importantly, improving scientific literacy can contribute to depolarizing ideological viewpoints, which has become increasingly necessary with the politicization of science, i.e., exploitation of the inherent uncertainty in science to undermine valid scientific findings or consensus (4–6). During classroom literature discussions, the selection of articles with real world significance has a critical impact on student engagement (2). Clinical trial studies have tangible relevance and are especially useful for emphasizing fundamental concepts in experimental design and quantitative analysis because of their necessary, inherent rigor.

We sought to harness the surge of interest in COVID-19 clinical research to engage students in a literature discussion that reinforces key concepts taught in an introductory biology course (Table 1). We present an activity for remote, synchronous analysis of the current clinical trial publication, “Remdesivir for the Treatment of COVID-19: Final Report” (7). We incorporated elements of the “Figure Facts” approach (8) to literature discussion by emphasizing data interpretation over the article’s text narrative (Appendix 1).

We also used features of the “Interactive Journal Club” (9), originally designed for medical student literature discussions, which allows active participation even when students fail to read in advance (Appendix 1). This approach highlights experimental design and prompts students to consider how they would devise certain aspects of the study.

Although the COVID-19 pandemic has provided a wealth of current and topical literature, it has also caused rapid fluctuations in student needs, safety guidelines, and university policies, necessitating that in-class activities be readily adaptable to multiple teaching modalities. We highlight the versatility of the classroom response system Pear Deck, an add-on for Google Slides, for literature discussion activities that can be readily implemented during in-person, hybrid, remote synchronous, or remote asynchronous classes.

The project was reviewed by the University of North Carolina Asheville Institutional Review Board for its use of student feedback and was granted Exempt status.

PROCEDURE

Preparation

Students were assigned an annotated article PDF to read 1 week before the activity. Annotations included highlighted...
and numbered text (Appendix 2) to draw attention to key points during independent reading and in-class discussion (10). Although other classroom response systems could also be used with this activity, we chose to use Pear Deck because it allows (i) interactive questions to be integrated into a Google Slides presentation; (ii) a variety of question types (text input, multiple choice, dragging, and drawing); (iii) flexibility to use the same activity synchronously or asynchronously; (iv) straightforward export of student responses for grading; (v) automatic export of slides and individual responses to students; and (vi) free use for students (and instructors, though with limitations on question types).

### Implementation

We conducted the activity synchronously via Zoom, using the “Instructor-Paced” option on Pear Deck, over a 2-h period (Table 1). Students were informed in advance that the activity would be graded. To encourage open discussion and facilitate learning, grading emphasized participation and effort over accuracy (Appendix 3). The instructor led the discussion and presented master slides on Zoom, while students followed on their devices and were automatically prompted to respond to interactive questions (Appendix 2). Student’s anonymized responses were displayed on-screen and discussed by the instructor to highlight key points and correct misconceptions. Students were encouraged to use the Zoom chat box and their microphones to contribute.

### Content

Brief explanatory slides providing background information on the life cycle of SARS-CoV-2 and mechanism of action of remdesivir (Appendix 2, slides 3 to 5) were followed by discussion prompts (Appendix 2, slides 6 to 35) addressing predetermined Student Learning Objectives (Table 2). To clarify the organization of journal articles, students were asked to identify elements of each section of the paper. To emphasize experimental design concepts, students developed their own title and hypothesis for the paper and answered questions about the importance of a placebo control, double-blinding, randomization, an ethics review board, and independent and dependent variables. For discussion of the Results section, students interpreted the meaning of confidence intervals, described how descriptive statistics were reported parenthetically in text, and answered questions interpreting tables and figures. Breakout rooms of three to four students were used for brief (about 5-min) discussions of key figures; students were provided prompts and shared responsibility for typing the group’s response into Pear Deck. Finally, for the Discussion section, students wrote their own takeaways, evaluated the reasoning behind the authors’ chosen discussion points, and reflected on how the current data conflicted with prior studies.

### Versatility

This activity can be adapted for asynchronous learning by launching a “student-paced” Pear Deck session, which...
we did for several students unable to attend synchronously. The student learning experience appeared similar, but we recommend providing accompanying video to explain difficult concepts and ensure students remain on track in their interpretations. For fully asynchronous implementation, we suggest students work in groups. We have also used Pear Deck activities in hybrid classes, where some students are present in person and others simultaneously participate.

TABLE 2
Student learning outcomes

| At the end of this exercise students should be able to:                                                                 | Bloom’s level |
|-----------------------------------------------------------------------------------------------------------------------|---------------|
| 1. Assign statements to the appropriate section of the paper.                                                         | Understand    |
| 2. Identify from a paper’s Introduction the motivating factors and/or justification for the research.                  | Remember      |
| 3. Propose a hypothesis based on the stated purpose of the research.                                                   | Create        |
| 4. Name appropriate treatments (=independent variable) to test the hypothesis, including description of a control.      | Analyze       |
| 5. Explain why randomization in assignment of subjects and double-blind design are necessary for unbiased research.     | Analyze       |
| 6. List appropriate dependent variables for the study, given the hypothesis and treatments used; identify the dependent variable(s) actually measured by the researchers. | Analyze; Understand |
| 7. Interpret data in figures and tables and connect those data to summaries in the paper’s Results section.           | Analyze; Apply |
| 8. Interpret descriptive statistics reported in the paper’s Results section.                                          | Analyze; Apply |
| 9. Synthesize data into main conclusions drawn from the study.                                                        | Create; Evaluate |

TABLE 3
A selection of student responses to the activity

Responses*

“I feel that . . . discussing the paper more in depth really made the paper interesting and made me understand the no., specifically, more.”

“Picking it apart by pieces makes it easier to understand, especially the graphs. Overall the paper was a good read and interesting.”

“the hardest part was understanding the diagrams but after today’s class I feel very confident”

“it was interesting to know that much information about something that’s so prevalent in all our lives right now”

“I found the paper very interesting, but I found the graphs somewhat difficult to interpret.”

“the hardest part for me was identifying independent variables but I feel comfortable now”

“I understood most of the paper. It was easy for me to understand the statistics. I enjoyed talking about the paper in class so that we could discuss each figure.”

“I enjoyed reading this paper and learning how to read scientific papers more. Trying to figure out how to read the graphs was the hardest part. No questions”

“Went great, hate that we started running out of time, love being active and a part of the class even though we are not in person or together. Like this sense of being a class more than just Zoom. Really helped break down this article, really cool, ended up sharing it with my sister so she could learn about it and check it out.”

“I thought it was great and very interesting personally. Especially with my mom being a nurse, this was really cool! The only thing I had a struggle with was the graphs and the stats.”

“This paper was interesting to read and understand, the hardest part is knowing that people are still dying due to this virus and while there are treatments, there aren’t cures.”

Mid-Semester Poll

Rate your level of agreement with the following: “Journal article discussions in class are interesting and a useful application of course concepts.” Disagree = 1, Agree = 5. **Mean Response: 4.05 (n = 21)**

*Responses were solicited in the final slide of the activity (Appendix 2, slide 36).

**Responses were solicited in an anonymous midsemester feedback form following implementation of the current activity and one other similarly formatted Pear Deck journal article discussion.
remotely via livestream. The activity is amenable to the discussion of other primary literature and has been adapted in our classes to cover additional articles.

CONCLUSION

The activity received positive feedback from students in all six course sections in which it was implemented (Table 3). Students remained engaged—a challenge during a 2.5-h class—and several survey comments indicated disappointment at not having more time for discussion. Comments reflected enthusiasm for the topic’s relevance; some reported sharing findings with friends and family. Students expressed optimism at seeing progress in COVID-19 treatment but also concern about the continued lack of a bona fide cure. Instructors should be sensitive to the potentially emotional nature of the material, which may vary widely depending on students’ personal experiences. The most challenging aspects for students included understanding terminology, identifying variables, and interpreting descriptive statistics and graphs. In general, students reported feelings of accomplishment in their comprehension of the paper. Altogether, preliminary implementation of this activity suggests that discussion of COVID-19-related literature during the ongoing pandemic is a highly engaging method for the application of experimental design and quantitative skills in introductory biology courses.

SUPPLEMENTAL MATERIAL

Appendix 1: Elements of figure facts and interactive journal club included in this activity
Appendix 2: Journal discussion in Pear Deck, suggested content
Appendix 3: Journal discussion in Pear Deck, grading rubric

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