Utilizing Technology to Enhance Student Interactions with Primary Research Papers

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Challenge:

Although many students have some familiarity with primary literature, my experience has been that they often struggle to appreciate the complexity and nuances of these resources. I believe that the challenges of teaching students how to read primary literature effectively are multifaceted. First, research studies are hard to read. They are dense and require a level of prior knowledge that is hard for professional researchers to attain, much less students who are not experts in the fields being explored. Secondly, it is hard to assess a student's understanding of primary literature. The common forms of assessment are options such as reading quizzes, which are quick, but generally can't assess the depth of knowledge gained from reading a paper, or more in-depth assignments such as journal clubs, which may provide a more accurate assessment of a student's understanding of a paper but are generally very time intensive and stressful for students.

Desired Result:

My goal was to provide structured opportunities for the upper-division students in my MCDB 4444 (Cellular Basis of Disease) course to interact with numerous primary resources through a variety of methods that encouraged in-depth analysis of research papers. These assignments were low stakes and allowed for student choice throughout the semester. I utilized research-based instruction strategies such as discussions, summarizing, drawing, and reflection to encourage student engagement and interaction with primary texts.

Project Summary:

MCDB 4444 (Cellular Basis of Disease) is a course that I taught for the first time during the spring 2024 semester. During the final 10 weeks of the course, student groups presented both an overview lesson focused on a specific disease (~1hr) as well as a primary research paper (~1hr). The focus of this project is for the majority of the students who were **not** presenting each week. These students were required to read the research paper that was being presented that week and complete one of three assignment options that addressed a set of learning objectives for reading, interpreting, and evaluating scientific literature. The options students could choose from were:

> **Collaborative Annotation:** Students were required to collaboratively annotate the weekly paper using the Hypothesis software. To earn full points students needed to fully annotate the paper and include a post that described which of the figure panels (up to 2) they believed were the most important to support the conclusions of the paper. The post had to include the research question being asked, the methods used to find the answer, and the data that supported the conclusions that could be drawn.
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> **Individual Annotation:** Students were required to individually annotate the weekly paper. To earn full points students needed to fully annotate the paper and pick at least three figures and annotate the limitations of the experiment or inconsistencies between the data and

conclusions that the authors drew. Annotations needed to include a statement of the question being addressed by the figure, the methods used, and what inconsistency or limitation exists. The annotation also needed to include an assessment of whether this inconsistency/limitation inhibited the student's ability to trust the general conclusions from the paper.

Schematic Design: Students needed to determine which figure panel(s) (up to 2) they believed were the most important to support the authors main conclusion from the paper. Using BioRender they created a schematic that briefly depicted the methods used to create the data and a molecular model of what was being shown in the figure**.** The schematic must include a sentence stating the research question being addressed by the figure and a sentence stating the conclusion from the figure. The schematic could include words but nothing longer than a full sentence.

The assignments were graded on the rubric below. Students were only required to complete assignments for seven of the nine papers they were not presenting (or drop their two lowest grades) further enabling flexibility for students.

8 to >6.0 pts Accepted	**6 to >4.0 pts Minor Revisions**	**4 to >2.0 pts Major Revisions**	**2 to >0 pts Not Accepted**
The response includes a description of the question being addressed, the methods utilized, conclusions drawn, and the data that supports them. This information is used to support the author's assessment of importance/inconsistencies/limitations This information is provided in an articulate, accurate, and in-depth manner	The response includes description of the question being addressed, the methods utilized, conclusions drawn, and the data that supports them. This information is used to support the author's assessment of importance/inconsistencies/limitations The information provided may have errors in accuracy, be unclear, or not at the level of depth expected	The response is missing 1-2 required elements of the response such as the description of the question being addressed, the methods utilized, conclusions drawn, and the data that supports them. This information may or may not support the author's assessment of importance/inconsistencies/limitations The information provided may have errors in accuracy, be unclear, or not at the level of depth expected	The response may be missing multiple required elements of the response such as the description of the question being addressed, the methods utilized, conclusions drawn, and the data that supports them. This information does not strongly support the author's assessment of importance/inconsistencies/limitations The information provided may have errors in accuracy, be unclear, or not at the level of depth expected

I also collected data on student perceptions of these assignments in an end of year survey.

<u>Outcome:</u>

Broadly, this project was successful. Most students were able to meet the expectations of the reading assignments throughout the semester and meet the stated goals of the project. I derived this

information from the quality of assignments completed (Appendix A-D). Furthermore, although I did not require students to take advantage of the different modalities of the assignment (collaborative annotation, individual annotation, or graphic design), over half of the students in the course tried more than one option throughout the semester, and approximately the same percentage noted that they appreciated having the option for different versions of the assignment (Appendix E). This was also specifically noted as beneficial in several student survey responses (Appendix F, Quote 6)

Furthermore, students appeared to perceive these assignments as useful (Appendix F, Quotes 1-6). Based on the student surveys, over 75% of students believed that they read papers more deeply because of the reading assignments and became more comfortable reading primary literature in general through this course (Appendix E). Most students didn't perceive that they spent significantly more time on this course than their other upper division courses, meaning that these assignments were not so onerous as to make the course load overwhelming. However, the majority of students did feel that they learned as much or more in this course than their other upper division courses (Appendix G).

The least successful part of this project was the grading and providing feedback to students. I had originally planned to use a more complex rubric, but to streamline grading I ended up condensing the rubric. However, because of this, I found myself writing individual comments to students to indicate specifically what could be improved. This resulted in delayed feedback, which made it hard for students to know what to correct as well as leading to some ambiguity of what the important aspects of the assignments were (Appendix F, quotes 7-8). For future semesters, I will return to my original idea of splitting up the rubrics for the different versions of the assignment, while also incorporating the requirement of fully annotating the paper into the rubric. I will also focus my learning goals to better articulate what I believe is important for students to get from these assignments.

Reflection:

Program reflection: I enjoyed exploring some of the nuanced topics that we covered in the first semester of this program. I also thought that it was useful to read resources that had clear points of view, even if I didn't always agree with them. It was interesting to get a sense of where some of the field of education is coming from. I don't feel like I have a strong foundation for many of these topics as they generally are not focused on in my experience in the natural sciences. I also appreciated that this group felt like a very safe space to have discussions that addressed some of these challenging topics in which it really felt like there wasn't necessarily a right answer, but where it would have been easy to label someone one way or another, which I didn't feel happened with our group.

Project reflection: I strongly believe that being able to read and evaluate primary literature is an essential skill for undergraduate students in the biosciences who are going to enter a professional STEM field. Being able to read and understand this type of resource is a learned skill, and I wanted to ensure that my students were able to have multiple opportunities to interact with a variety of papers. By participating in the Faculty Fellows program, I was forced to make the space to think deeply about how I wanted to approach this issue and what tools might be available for me. While I'd like to say that I would have done this anyways, I don't necessarily believe that that would have been the case. Therefore, I think this program really helped me focus my intention into something that was beneficial and meaningful for my students.

Artifacts:

All artifacts are listed as appendices and can be found in the shared folder HERE. A list of what is shown in each appendix is provided below.

Appendix A

A representative list of collaborative annotations collected from Hypothesis from one of the reading assignments this semester.

Appendix B

A representative list of individual annotations collected from Hypothesis from one of the reading assignments this semester

Appendix C - D

Representative examples of schematics made for the reading assignments this semester

Appendix E

A graph indicating students' opinions regarding reading primary literature and the reading assignments for this course. Color coding is an artifact of Canvas and is not meaningful. (23/24 students responded anonymously to survey)

Appendix F

A selection of student quotes from the end of semester survey

Appendix G

Graphs indicating students' opinions about how much time they spent on my course compared to others (top graph) and how much the felt like they learned in my course compared to others (bottom graph). Color coding is an artifact of Canvas and is not meaningful. (23/24 students responded anonymously to survey)