INTRODUCTION

The pedagogical value of exposing undergraduate students to primary literature is undeniable. The formats educators use to incorporate reading primary literature into the course curriculum vary, ranging from organizing a journal club independent from the lectures and laboratory exercises, to having students write a summary or give a presentation in class, to building the entire course upon the primary literature (1–4). The strategies we use to teach our students to read the primary literature are just as diverse. For example, there is the traditional “start with the tables and figures” strategy, the data-centered strategy to enhance students’ data interpretation skills (5), and the C.R.E.A.T.E. (Consider, Read, Elucidate the hypotheses, Analyze and interpret the data, and Think of the next Experiment) strategy that intentionally analyzes each section of each paper (6). Some of us teach our students to skim over papers and some want them to dissect each sentence critically. There is a value in, and a place for, each reading technique and each course curriculum integration approach. Nonetheless, all approaches have one thing in common: most students are not thrilled about the experience. When I asked my students in two classes to use five adjectives to describe their experience in reading the primary articles, there were more negative than positive ones (Fig. 1). The reasons for these negative responses could be that students do not yet have enough knowledge to appreciate the research, and the language and writing style scientists use to communicate are unfamiliar and potentially intimidating. However, I believe that while students may not have heard of every technique and learned about every concept in a paper, they have enough background to appreciate the science. It is the fear of not being able to understand the paper before reading it that elicits negative emotions, which then compound to produce the negative learning experience. To help students overcome this initial obstacle so they can have a better overall appreciation of a paper, I added a simple 10- to 15-minute activity before giving students the paper. Students were presented just the title of the paper with three guiding questions. They then continued to read the paper as they would in other classes.

PROCEDURE

The title (abstract not included) of the paper was projected on the screen, with three guiding questions: 1) What was the research question/hypothesis, 2) What were the approaches/methods, and 3) What were the results/conclusions of this study. Students were given 10 to 15 minutes to jot down their thoughts. They were also reminded that there was no need to be technical. Students were then given the paper to read and to compare what they had jotted down with what was presented in the paper.

The key to the success of this activity is that the instructors need to be mindful about choosing the papers. For example, I incorporate four papers in my microbiology class and often start with “Microbial biogeography of public restroom surfaces” (7). The title is self-explanatory and the paper is relevant, according to almost all students. For the second paper, I often choose one with a longer title, such as “Sequencing ancient calcified dental plaque shows changes in oral microbiota with dietary shifts of the Neolithic and Industrial revolutions” (8). The cliffhanger tone of the title piques students’ curiosity not only in science but also in history and archaeology. The choice of the remaining two papers varies, but I usually choose one with a short and all-encompassing title, such as “Sewage reflects the microbiomes of human populations” and one with a specific and...
technical title, such as “γ-butyrobetaine is a proatherogenic intermediate in gut microbial metabolism of L-carnitine to TMAO” (9, 10). Students may need help with the definitions of some words before they move through the three guiding questions.

Occasionally, I let students read the paper on their own and come back with a written summary or an oral presentation. More often, the reading of the paper takes place during the laboratory period. I use the first waiting period during a laboratory exercise for this activity, followed by a brief discussion. I then give students the paper and encourage them to read it and compare it with their response to the title whenever they are waiting to proceed to the next step of the laboratory exercise. We then typically spend 10 to 15 minutes to discuss the paper at the end of the laboratory period.

I have taken this approach in more than 10 classes and did pre- and post-activity surveys with IRB approval in three of the classes.

CONCLUSION

Students responded positively to this exercise in the post-activity surveys. Although a few students were (unrealistically) disappointed that this method did not help them produce answers to the three guiding questions that perfectly matched the paper, most students wrote comments such as “surprisingly made the paper easy,” “helped me tune in,” “I saw the big picture,” “I feel smart,” and “less overwhelming.” Some decided to adopt this method to read papers in other classes, even nonscience classes. One student suggested that professors should use this method to teach students how to write better titles for papers. For the majority, it helped them overcome their initial fear and gain overall understanding of the paper. More specifically, the first guiding question highlights the hypothesis in the introduction section for the students, the second guiding question makes the materials and methods section less overwhelming, and the third guiding question prepares them to read the results and discussion sections critically.

This activity is easy to implement and it costs little time and resources, if any. It can be used to help students skim through a paper quickly if appreciating the big picture is the learning goal, or it can provide an entryway to dissecting and assessing a paper critically and thoroughly. Additionally, it can be used in conjunction with other primary article reading strategies. In summary, this is an easily implemented, low-stakes activity that enhances students’ learning experience in reading primary literature.

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