Improving Scientific Literacy in Collegiate Biology Students

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Abstract

Reading scientific literature plays a large role in a college student's education, especially for STEM majors. Our previous research revealed that, compared to faculty, undergraduates who read an article have more comprehension difficulties and possess less prior knowledge of scientific methods and experimental design. These results suggest that resources to supplement student knowledge might allow students to better comprehend scientific literature. We hypothesize that using scientific literature annotated with informational links and videos will lead to increased comprehension of the article. For this study, we used four articles annotated through the "Science in the Classroom" initiative. Students read and discussed either the original articles (comparison) or the annotated versions (treatment). We compared student performance in quiz questions that tested factual and technical knowledge as well as comprehension in the first and final quizzes of the semester. A three-way ANOVA revealed a significant interaction between question category and pretest/posttest differences in scores by method (p<0.001). Paired t-tests show no significant difference between scores of the treatment group and article content, as well as comprehension (based on Bloom's taxonomy levels, Crowe et al., 2008).

Introduction

• Structured discussions of scientific literature improve critical thinking in undergraduates within the cell biology classroom (Segura-Totten and Dalman, 2013).

• Undergraduates face more comprehension difficulties and possess less prior knowledge of scientific methods and experimental design when reading scientific literature compared to faculty.

• Annotated articles are available online and contain glossaries, videos explaining complex techniques and concepts, as well as background information to help students understand experimental processes and goals (AAAS 2017).

Methods

• Students were given an assessment of their scientific literacy skills (TOSLS) at the beginning and the end of the semester.

• Discussions replaced traditional laboratory.

• Quizzes were administered for each article after two discussions on the material.

• Multiple choice (MC) quiz questions tested knowledge of techniques and article content, as well as comprehension (based on Bloom's taxonomy levels, Crowe et al., 2008).

Results

Figure 1. Student knowledge and comprehension of articles. Quiz scores in questions testing for knowledge of techniques (A) and knowledge (B) or comprehension (C) of article content were compared between treatment groups. Scores in the quiz that assessed material on the first article, "Pre": final quiz, "Post". A) There is no significant difference between pre/post technique knowledge scores for comparison or treatment groups (p=0.631; p=0.575). B) There is a decline in content knowledge scores for both groups (p<0.001). C) There is no significant difference between pre/post technique knowledge scores for comparison or treatment groups (p=0.915; p=0.153). Comparison (N=66), blue; treatment (N=24), red.

Figure 2. Gains in scientific literacy skills. Students were assessed using TOSLS in a pretest/posttest format. Learning gains for students who scored in the lowest quartile on the initial TOSLS, "Low"; students who scored in the upper three quartiles, "High". Comparison low (N=21); treatment low (N=9); comparison high (N=49); treatment high (N=14). There was no significant difference between "High" comparison and treatment groups (p=0.4156). We observed a trend where scores for the "Low" treatment group were higher than those for the "Low" comparison group (p=0.0900). Comparison, blue; treatment, red.

Conclusions and Future Directions

• Preliminary findings suggest that students who use annotated articles may have improved scientific literacy and comprehension compared to students who read the original articles.

• Analysis of MC quiz questions suggests a decline in content knowledge in both treatment and comparison groups.

• Findings do not include the treatment semester in progress (Spring 2019, N=67). Further analysis will include the larger sample size for the treatment group. This new sample will allow us to isolate instructor as a variable in our quantitative analysis.

• Answers to open-ended quiz questions and assignment questions will be scored and analyzed. Quantitative analysis of these will triangulate MC quiz questions and TOSLS scores.

• We will score end-of-semester student critiques of research articles for critical thinking to compare this skill in comparison and treatment groups.

References


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