

Teaching Undergraduate Science Majors How to Read Biochemistry

Primary Literature: A Flipped Classroom Approach

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Framework

Reading scholarly articles is a crucial information literacy skill for undergraduate science majors. In previous years students were required to read scholarly articles and to write a summary report in an upper-level biochemistry course. Students expressed difficulties in reading scholarly articles and identifying the appropriate information needed. To remedy the situation, an integrated approach to teaching information literacy skills was developed and implemented.

The biochemistry course at our institution is typically comprised of students majoring in Chemistry and Biology, with varying degrees of prior training in information literacy skills. Some have no previous experience with reading scholarly papers, while others have written several review articles in other science courses. The class meets twice a week for a 75 minute lecture. Unfortunately, the content-rich nature of this course precludes extensive student training by library staff.

A flipped information literacy session appeared to us as the best possible solution to accommodate the different information needs and prepare students for the research assignment within a limited amount of time. The methods of flipped classrooms have been implemented in various disciplines (Bull, Ferster & Kjellstrom, 2012; Engin & Donanci, 2014; Findlay-Thompson & Mombourquette, 2014; Forsey, Low, & Glance, 2013; Hantla, 2014; Strayer, 2012; Youngkin, 2014) and in library instruction sessions (Arnold-Garza, 2014; Datig & Ruswick, 2013; Lemmer, 2013). Through the flipped method, students gain the foundational knowledge and skill sets needed prior to the class meeting. This allows the faculty members to select a few topics that warrant discussion, lessening the time spent in lecture and engaging students in learning through interactive activities during the lecture period.

An innovative technology that could be used for flipped classrooms is the TED-Ed website (<http://ed.ted.com>), which offers valuable open-access instructional videos. It also allows instructors to create lessons by adding additional content to original videos, such as multiple choice or open-ended questions, discussion topics, and links to other useful resources. The lessons can be shared easily with students, and instructors can monitor the progress of students' learning and offer guidance through interactive tools, if necessary.

Appendix 1 summarizes the activities that we implemented in our class. First, scientific contents relevant to the article were taught in a traditional lecture format. Students then received

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an assigned article to read and a link to the TED-Ed course website. Students completed their first flipped lesson and reported their difficulties using the course website. After gathering students' responses, the materials to be covered during the following in-class session were tailored to meet students' needs. After the session, students were then instructed to thoroughly read the supplied article. Students' comprehension on the article improved significantly, compared to that from previous semesters.

Making it work

The main goal of this assignment was for students to be able to read a scholarly article on protein purification (Bocchini & Angeletti, 1969), to understand the role of each step in the purification process, and to understand how the authors analyzed the purity of purified proteins. The faculty member strategically chose a research article that provided significant details on the protein purification procedures. The core concepts and methodologies of the protein purification were taught in a lecture prior to the distribution of the assignment.

To create the flipped lesson, the librarian searched for the instructional videos on reading primary literature in peer-reviewed teaching resource repositories, such as Peer-Reviewed Instructional Materials Online (PRIMO) and eXplore Chemical Information Teaching Resources (XCITR). The search was also extended to YouTube. Since videos on YouTube were not peer-reviewed, their quality and the credibility were carefully evaluated.

A video was chosen and a course page was created on the TED-Ed website (<http://ed.ted.com/videos>). The following items were added as customized content to the course page (Figure 1): the lesson instruction (Watch), multiple-choice/open-ended questions (Think), additional resources (Dig Deeper), and discussion forum (Discussion). The quiz questions were designed to help students assess their knowledge on the organization of scholarly articles. Additional resources, such as links to videos on reading tips and strategies, were added to reinforce their learning. A hyperlink to the finalized course page was distributed to the students, and the students could then initiate the flipped lesson at their leisure.

Let's Begin...

This video will teach you how scholarly articles are arranged. First, you **Watch** the 2-minute informational video; then click on **Think** to answer three questions to reinforce your knowledge; then break the assigned article into sections as instructed in the video. After you read the article section by section, remember to participate in **Discussion**. Further readings are available in **Dig Deeper**.



Watch

Think

Dig Deeper

Discuss

Figure 1. Customized Ted-Ed Course Website³

In the flipped lesson, students were instructed to 1) watch a video on the structure of the scholarly article (UTSALibraries, 2013), 2) take a quiz, 3) watch additional videos if necessary, 4) read the assigned article, and then 5) participate in the online-class discussion forum. At this point of the exercise, a comprehensive understanding of the article was not expected. Students were instructed to read through the article simply to identify unfamiliar terminology and experimental approaches. Any terms, procedures, or concepts that the students were unfamiliar with were discussed using the online forums on the course page.

TED-Ed provides real time updates on students' progress and comments. The faculty member and librarian collected data on students' completion of the lesson, performance on multiple-choice problems, and comments on the discussion forum.

It is interesting to note that we received a wide range of responses, from simple terminology questions to more fundamental queries, such as interpreting graphs and understanding methodologies. Additional separate resources, tailored to students' self-identified problems, were provided. One of the advantages of this approach is selectively providing more resources for students that lack prior experience without burdening well equipped students.

Prior to the in-class session, the librarian and faculty member collectively decided on topics to be discussed. The librarian presented the library resources to search for scientific terms, shared common challenges with reading scholarly articles, and provided reading tips. The instructor provided an explanation for scientific concepts, such as the role of specific columns used for the protein purification, types of experimental data collected, and how to interpret the graphs.

After the information literacy session, students were instructed to thoroughly read the same article on their own. Lists of questions that guided their reading, as well as the in-class group discussion were provided as additional tools to deepen their understanding. Figure 2 demonstrates the four steps of implementing flipped lessons.

³ Video Source: Article Analysis (2013) created by UTSALibraries

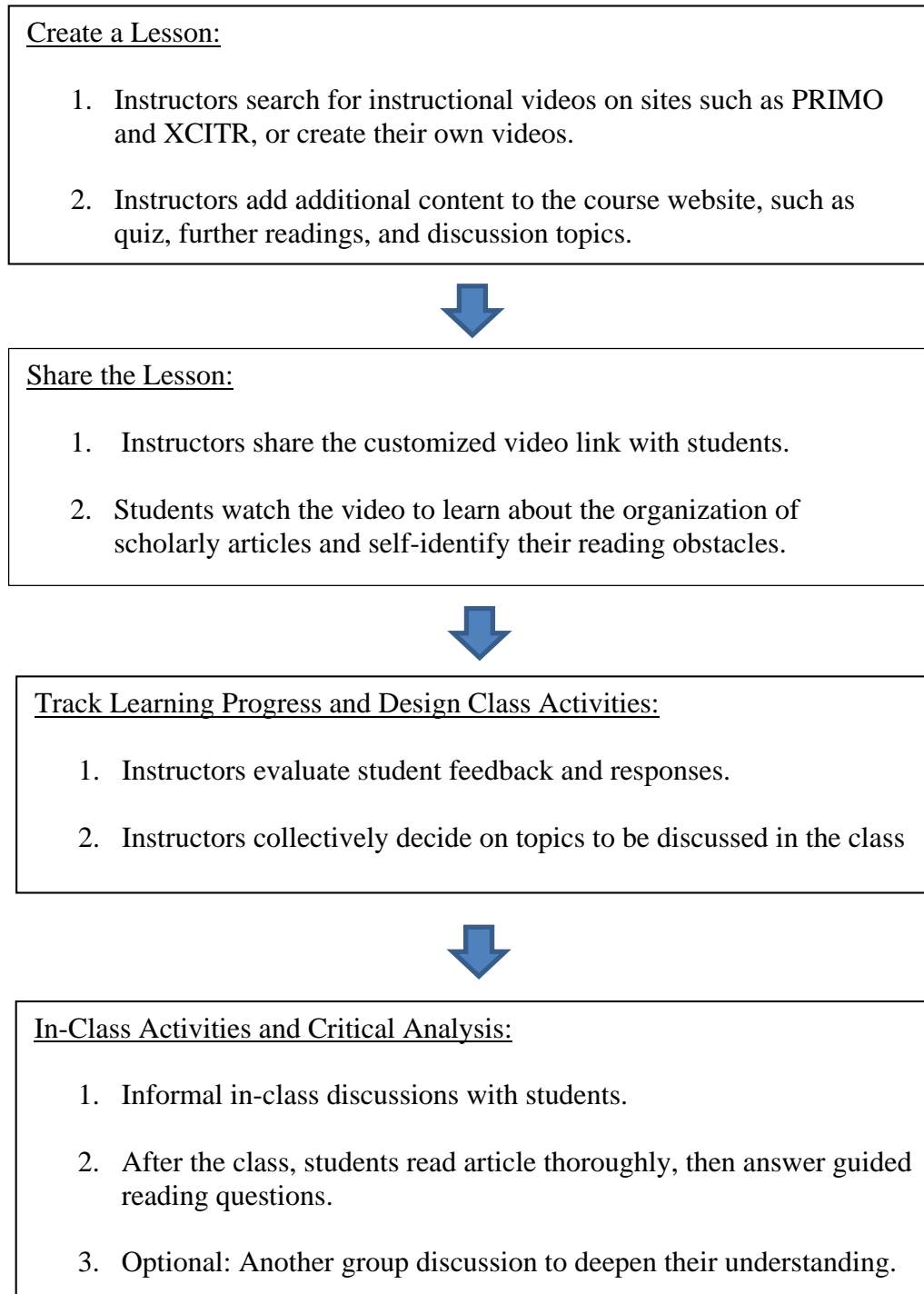


Figure 2. Four Steps of Implementing Flipped Lessons

Overall, the flipped video and class discussion more than adequately prepare students for reading the article without demanding a large fraction of the lecture time. Students provided positive comments on those activities.

Implications

This article highlights the steps of designing a flipped information literacy session to engage students in reading primary literature. Individual activities outside of lecture, such as flipped videos, appeared to be a viable method to accommodate students with various backgrounds. Student feedback suggested this approach enhanced their learning experience. The flipped lessons offer students flexibility in controlling their learning pace. They can also serve as an assessment tool: the instructors can integrate the class surveys in the lesson easily. Instructors can also create their own tutorials and videos that are tailored specifically to the course. The lessons created with TED-Ed have a few advantages compared to those videos and resources embedded within learning management systems. The instructors can invite students from different classes to take the lesson and the lesson can be updated easily by adding and deleting questions, links, and discussion topics. The course materials on TED-Ed can also be shared with people who do not have access to the classroom management system. Some institutions have restrictions on the librarian access privileges to the classroom management system. The TED-Ed platform offers librarians flexibility and control over the design and revision of the flipped lesson. Furthermore, the strategies and technology can be easily applied in other disciplines.

Appendix

Appendix 1. List of Customized Content

Lesson Instruction

This lesson will teach you how scholarly papers are arranged. First, **Watch** the 2-minute informational video; then click on **Think** to answer three questions to reinforce your knowledge; then break the assigned article into sections as instructed in the video. After you read the article section by section, remember to participate in the **Discussion** forum. Further readings are available in **Dig Deeper**.

Think⁴

1. Which part of a research article may include the protein purification procedure?
 - A. Methods
 - B. References
 - C. Results
 - D. Introduction

⁴ Questions were adapted from the "Article Analysis" module on the Peer Reviewed Instructional Materials Online

(PRIMO) site. Retrieved from: http://utsa.edu/tlc/Learning_Technology/article_analysis_lm/index.html

2. Which part of the article contains the “take home” message?
 - A. Results
 - B. Introduction
 - C. Conclusion
 - D. Discussion
3. Which part of the research article provides a short summary?
 - A. Header
 - B. Citation
 - C. Introduction
 - D. Discussion

Dig Deeper

Additional Resources for you to explore:

1. The "How to Read a Scientific Paper" Tutorial from Purdue University Libraries - some reading tips are included in this tutorial.

<https://www.lib.purdue.edu/help/tutorials/scientific-paper#mainmenu>

2. The "How to Read a Scientific Article" document was created by faculty members in Rice University - it has a template for taking notes on research articles.

<http://www.owlnet.rice.edu/~cainproj/courses/HowToReadSciArticle.pdf>

3. Anatomy of an Article - from Arizona State University. Try "Dissect it" links on the sections of interest to you.

<https://askabiologist.asu.edu/explore/anatomy-of-an-article>

Discussion

1. From the short video, you should have learned how to analyze a research article. Break the assigned article into several sections. As you are reading section by section, which part is most challenging for you to comprehend? Why?
2. List all jargon that you found difficult during your reading.

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