JOURNAL OF CHEMICAL EDUCATION

Technology Report

pubs.acs.org/jchemeduc

Adopting Lightboard for a Chemistry Flipped Classroom To Improve Technology-Enhanced Videos for Better Learner Engagement

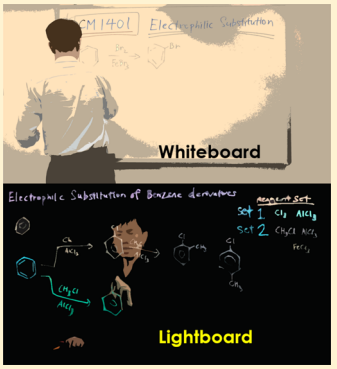
Fun Man Fung*

Department of Chemistry, National University of Singapore, 3 Science Drive 3, Singapore 117543

Institute for Application of Learning Science and Educational Technology (ALSET), University Hall, Lee Kong Chian Wing UHL #05-01D, 21 Lower Kent Ridge Road, Singapore 119077

Supporting Information

ABSTRACT: Currently there are two primary methods of recording flipped classroom videos: (1) using the white board and (2) screencasting a PowerPoint presentation. Both methods have several disadvantages. In the former, the presenter's body obscures the content. Both methods lack an element of human interaction between the viewers and presenter and require lengthy editing. These reasons discourage educators from adopting the flipped classroom. In this article, we share our motivations and experience with the Lightboard, an interesting method of filming with a glass board that addresses the aforementioned problems. This novel format, first introduced and developed by Professor Michael Peshkin at Northwestern University, could help achieve our pedagogy goal of engaging chemistry learners better by providing greater visual connection with the lecturer.



KEYWORDS: *High School/Introductory Chemistry, First-Year Undergraduate/General, Second-Year Undergraduate, General Public, Organic Chemistry, Internet/Web-Based Learning, Demonstrations*

TECHNOLOGY-ENHANCED TEACHING AND LEARNING

Modern technological advances have allowed and prompted educators to adopt new methods of teaching. In the same vein, the student demographic is changing as well. The current generation of students are tech-savvy and have access to a myriad of free higher education courseware online (MIT OpenCourseWare, edX, Coursera, etc.) and therefore place greater demand on the outcomes of their higher education from brick-and-mortar institutions.[1] Furthermore, studies have shown that modern students are more easily distracted.[2] Therefore, modern educators face the challenge of curating an effective and engaging experience for student learning.

In the face of these recent challenges, a new paradigm for teaching known as the "flipped classroom" has emerged.[3,4] Broadly speaking, the flipped classroom refers to a reordering of activities traditionally performed inside and outside of the classroom, namely, the delivery of information through lectures and problem solving.[1,5−8]

Pedagogical Theory in the Flipped Classroom

In a typical flipped classroom, students learn at their own pace through prerecorded video lectures outside class. Subsequently, problem solving activities are conducted during class to consolidate knowledge and help educators identify and address the difficulties students face, thereby enhancing the students' learning.[9] Figure 1 summarizes the key differences between the traditional and flipped classroom models.

A key feature of the flipped classroom approach is self-directed learning, where students are constantly engaged in the learning process rather than being passive learners.[10] Typical prerecorded video lectures for the purposes of flipped classrooms comprise the lecturer presenting on a whiteboard or narrated PowerPoint slides. In this aspect, students are active learners because they have the freedom to explore the lecture material at their own pace and have complete ownership over their learning. We believe that the active learning aspect of this portion of the flipped classroom can be enhanced by presenting the lecture material using the novel open source hardware "Lightboard" developed by Michael Peshkin from Northwestern University.[11]

Filming Using the Lightboard

The Lightboard is a set of lecture recording tools that allow production of high-quality videos where the presenter both faces the audience and writes on a glass board as they would in a regular class. It confers several advantages over typical flipped classroom videos and conventional classroom teaching.

Lightboard videos feature an unobstructed view of the lecturer, who simultaneously faces the audience and presents on a glass board (Figure 2). This is particularly useful for lecturers of STEM subjects, who often find the need to complement verbal explanations with equations or diagrams. This can be

Received: January 4, 2017
Revised: May 17, 2017
Published: June 9, 2017

DOI: 10.1021/acs.jchemed.7b00004
J. Chem. Educ. 2017, 94, 956−959

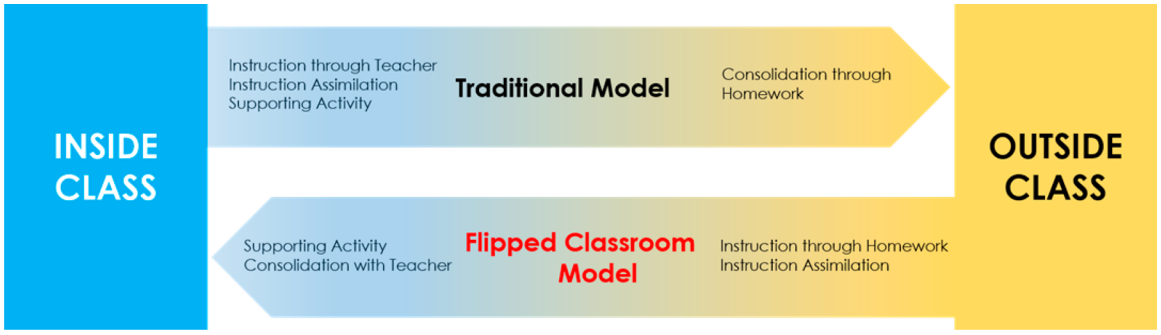


Figure 1. Traditional model vs the flipped classroom model.[10]

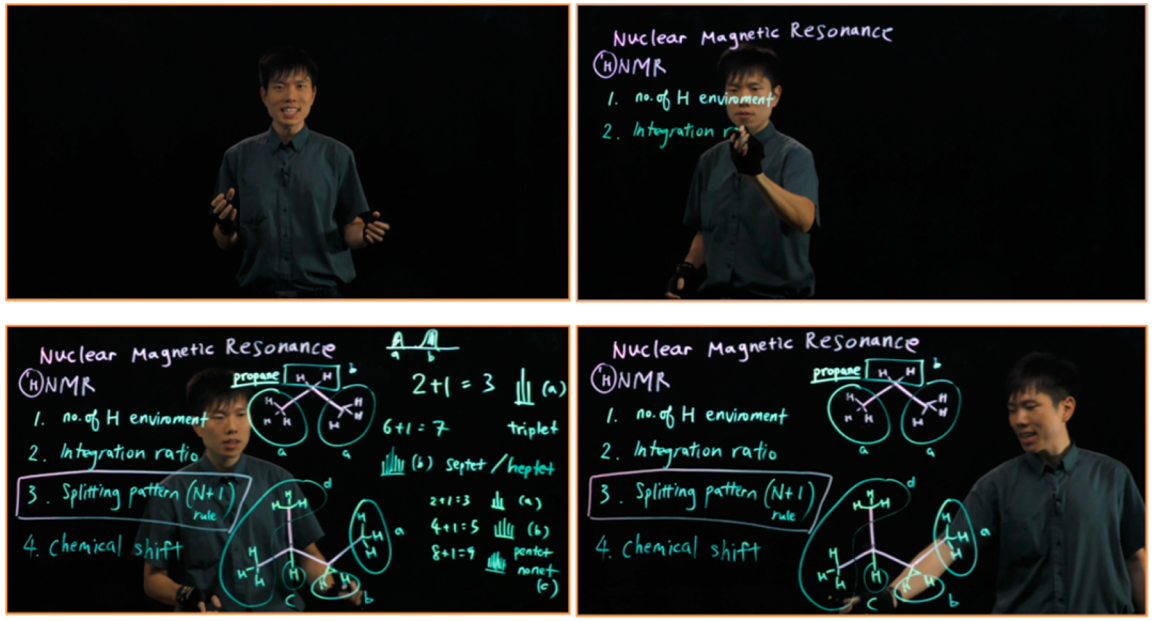


Figure 2. View of the presenter in the Lightboard video. Clockwise from top left: introduction by speech; commencement of writing; midway through the lecture; end of lecture.

done without any interruptions that they might face in a conventional classroom: questions from the audience or turning around to draw on the whiteboard. Furthermore, illustrations and diagrams from a computer can be overlaid on the Lightboard screen. These features of the Lightboard format allow for a dynamic and engaging way to convey concise information.[12]

Lightboard videos are arguably less logistically demanding than expected. The videos are recorded and disseminated immediately without the need for postprocessing or the ability to write backward. This is achieved using a simple setup comprising a glass board, lighting equipment, a video-recording device, and a mirror that laterally inverts the image.[13] We intend to investigate the effectiveness of Lightboard videos in the flipped classroom format through the course CM1401: Chemistry for Life Sciences.

METHODOLOGY

Background Information on Module CM1401: Chemistry for Life Sciences

CM1401 is an introductory course covering basic organic chemistry at National University of Singapore. The course material is based on the much-celebrated McMurry text[14] and is catered toward biology majors in their first year of study. It has been conducted in a flipped classroom format for the previous two academic years, and we are taking the opportunity to adopt the Lightboard format for several lecture videos to investigate its effects on student learning.

Flipped Classroom Approach for CM1401

CM1401 adopted the flipped classroom format over traditional teaching two years prior to this study because we found several drawbacks to conducting live lectures. First, the class size was accompanied by an increase in occurrences of common classroom distractions and in-class questions, which disrupted the flow of the lectures, making it difficult for students to achieve learning outcomes. Second, instructor-facilitated problem solving performed during class is the most effective way to learn organic chemistry but is performed at the expense of content coverage.[15] In view of these disadvantages of conventional lecture-based teaching, the class was flipped in the hope that students could explore the lecture materials at their own pace outside of class and reinforce their learning through guided problem-solving activities during class.

Flipped classroom video lectures for CM1401 were provided as PowerPoint voice-overs that lasted up to 40 minutes per video. Students found the videos to be useful for learning because they could be rewatched any time, as opposed to live lectures. However, the length of these videos might have

DOI: 10.1021/acs.jchemed.7b00004
J. Chem. Educ. 2017, 94, 956−959

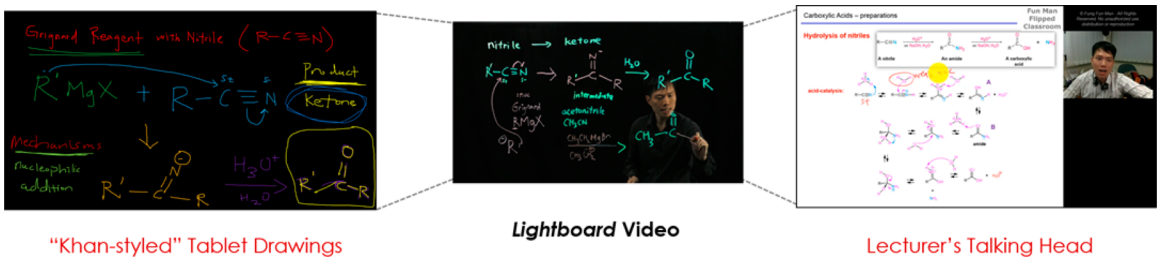


Figure 3. Both features of good lecture videos that students and lecturers wanted (left, Khan-style tablet writings; right, lecturer eye contact) were efficiently represented in a Lightboard video (center).

exceeded the attention span of most students. General criticism of these lecture videos centered on their length and content. Many students perceived the videos to be too long, thought that the voice-overs were "reading words off the slides" rather than teaching, and felt that they could have learned the material without watching the videos. Additional feedback suggested that the students would prefer shorter and more succinct "Khan Academy"-style videos, which primarily feature drawings on an electronic blackboard.[4]

Indeed, research findings from Guo, Kim, and Rubin show that shorter videos, Khan-style tablet drawings, and "talking-head" videos showing the face of the lecturer make for more engaging video content.[16] Efforts were subsequently made to enhance student engagement in the PowerPoint-based lectures by including an inset video of the lecturer speaking and surprises like blanking out content from the student copy of the lecture material. Ultimately, these solutions were still based on the PowerPoint voice-over format and often required considerable amounts of postproduction.

Adopting Lightboard for CM1401

In view of the feedback given for previous lecture videos of CM1401, we prepared several Lightboard videos to supplement existing lecture videos.[17,18] We found the Lightboard format easier to create than the existing PowerPoint voice-overs used in the module because the recordings were performed in the studio without the need for additional editing software. Furthermore, the final video footage featured elements that both students and lecturers wanted: primarily the Khan-style video format with eye contact from the lecturer (Figure 3).

Drawbacks of Lightboard

Despite the advantages of the Lightboard format, we faced two difficulties in the filming process. First, chirality cannot be explained with the use of physical model kits because of lateral inversion. Figure 4 shows the specific example of (*S*)-bromochloroiodomethane that we attempted to present in our Lightboard videos. There was an inversion of stereochemistry of the physical prop from *S* to *R* due in the final video. A simple workaround is to draw on the board rather than use physical model kits when stereochemistry is concerned because the image is laterally inverted twice, unlike the physical model. Second, the contents of the lecture have to be planned meticulously because the entire video has to be recorded in one sitting to avoid jarring breaks and the need for postprocessing.

Tips for Using Lightboard

Educators who wish to use Lightboard for recording videos can take advice from the following.

- Wear apparel without printed logos and brands.
- Be mindful of the bounded area of the glass board, as the camera will only capture a certain part of the board.

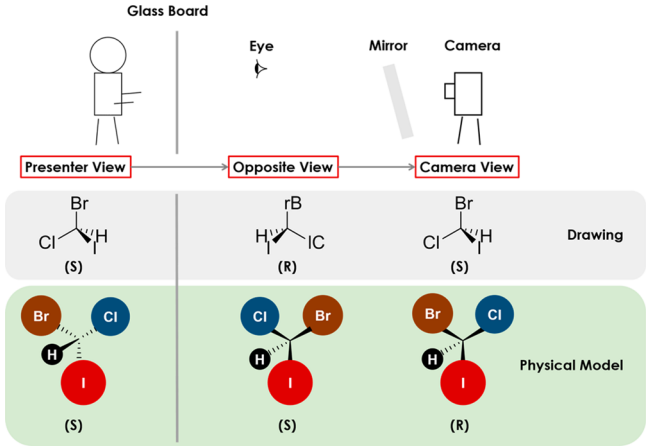


Figure 4. Illustration of presenting chirality on the Lightboard using a drawing (top) and a physical model (bottom) of (*S*)-bromochloroiodomethane. With a drawing, the image is laterally inverted twice, once through the glass and the second time through the mirror. The *S* center is therefore correctly represented in the video footage. However, the physical model is only inverted through the mirror and thus appears as the *R* enantiomer in the video footage.

- Remove jewelry and shiny objects before filming.
- Have a script in your mind of what is to be taught in the video before filming.
- The writing should be large enough (imagine that you are writing on a whiteboard).

CONCLUSION

The Lightboard format allows educators to prepare engaging, concise, and bite-sized videos with little to no postproduction. For the flipped classroom, it could potentially serve as a replacement for current whiteboard-based and PowerPoint-based lecture videos, whose lengths often exceed the average attention span and lack the level of human engagement expected from a typical lecture. In this work, we share the motivation for adopting and our experience in using the Lightboard format in a freshman course on organic chemistry.

ASSOCIATED CONTENT

Supporting Information

The Supporting Information is available on the ACS Publications website at DOI: 10.1021/acs.jchemed.7b00004.

Photos showing the Lightboard setup, television set display positioning, Lightboard lightings, and markers (PDF, DOCX)

DOI: 10.1021/acs.jchemed.7b00004
J. Chem. Educ. 2017, 94, 956−959

AUTHOR INFORMATION

Corresponding Author

*E-mail: fun.man@u.nus.edu.

ORCID

Fun Man Fung: 0000-0003-4106-3174

Notes

The author declares no competing financial interest.

ACKNOWLEDGMENTS

The author would like to express his gratitude to the NUS Office of the Provost for approving this iBLOC project (CM1401 Chemistry for Life Sciences) with the LIF-T grant. Special thanks goes to Chng Huang Hoon, Erle Lim, Goh Say Song and Richard Wong Ming Wah for their unwavering support of Technology-Enabled Blended Learning Experience (TEBLE). The author appreciates the encouragement from Robert K Kamei and Ravi Chandran. Special credit goes to Shawn Ng for his contribution towards this article.

REFERENCES

(1) Lowell Bishop, J.; Verleger, M. *Proc. Annu. Conf. Am. Soc. Eng. Educ.* **2013**, 6219.

(2) Gazzaley, A.; Rosen, L. D. *The Distracted Mind: Ancient Brains in a High-Tech World*; MIT Press: Cambridge, MA, 2016.

(3) Pienta, N. J. A "Flipped Classroom" Reality Check. *J. Chem. Educ.* **2016**, *93* (1), 1−2.

(4) Ruipérez-Valiente, J. A.; Muñoz-Merino, P. J.; Leony, D.; Delgado Kloos, C. ALAS-KA: A learning analytics extension for better understanding the learning process in the Khan Academy platform. *Comput. Human Behav.* **2015**, *47*, 139−148.

(5) Seery, M. K. ConfChem Conference on Flipped Classroom: Student Engagement with Flipped Chemistry Lectures. *J. Chem. Educ.* **2015**, *92* (9), 1566−1567.

(6) Luker, C.; Muzyka, J.; Belford, R. Introduction to the Spring 2014 ConfChem on the Flipped Classroom. *J. Chem. Educ.* **2015**, *92* (9), 1564−1565.

(7) Rossi, R. D. ConfChem Conference on Flipped Classroom: Improving Student Engagement in Organic Chemistry Using the Inverted Classroom Model. *J. Chem. Educ.* **2015**, *92* (9), 1577−1579.

(8) Trogden, B. G. ConfChem Conference on Flipped Classroom: Reclaiming Face Time: How an Organic Chemistry Flipped Classroom Provided Access to Increased Guided Engagement. *J. Chem. Educ.* **2015**, *92* (9), 1570−1571.

(9) Fulton, K. Upside down and inside out: flip your classroom to improve student learning. *Learn. Leading Technol.* **2012**, *39* (8), 12−17.

(10) Steed, A. The Flipped Classroom. *Teach. Bus. Econ.* **2012**, *16* (3), 9−11.

(11) Peshkin, M. How To Build a Lightboard. http://lightboard.info/ (accessed Dec 27, 2016).

(12) Skibinski, E. S.; Debenedetti, W. J. I.; Ortoll-Bloch, A. G.; Hines, M. A. A Blackboard for the 21st Century: An Inexpensive Light Board Projection System for Classroom Use. *J. Chem. Educ.* **2015**, *92* (10), 1754−1756.

(13) Frazee, J.; Anderson, M. *Learning Glass: Information, Specifications, Assembly Manual*; San Diego State University: San Diego, CA, 2014; http://its.sdsu.edu/docs/Learning_Glass_Specifications.pdf (accessed April 2017).

(14) McMurry, J. *Organic Chemistry with Biological Applications*, 3rd ed.; Brooks/Cole: Belmont, CA, 2015.

(15) Shattuck, J. C. A Parallel Controlled Study of the Effectiveness of a Partially Flipped Organic Chemistry Course on Student Performance, Perceptions, and Course Completion. *J. Chem. Educ.* **2016**, *93* (12), 1984−1992.

(16) Guo, P. J.; Kim, J.; Rubin, R. How video production affects student engagement: an empirical study of MOOC videos. *Proc. First ACM Conf. Learn. Scale Conf.* **2014**, 41−50.

(17) Fung, F. M. YouTube video titled Ketones and Aldehyde Nomenclature (Lightboard). http://tinyurl.com/ffmlightboard (accessed April 2017).

(18) Fung, F. M. YouTube video titled Ring Flip Chair conformer (Lightboard) http://tinyurl.com/ffmlightboard2 (accessed April 2017).

DOI: 10.1021/acs.jchemed.7b00004
J. Chem. Educ. 2017, 94, 956−959