Received: 3 May 2021 | Revised: 22 July 2022 | Accepted: 1 September 2022
DOI: 10.1002/bmb.21680

COVID-19

Biochemistry and Molecular Biology Education WILEY

A digital module-based experiential learning in protein biochemistry during the COVID-19 pandemic paradigm

Michelle Khai Khun Yap

School of Science, Monash University Malaysia, Bandar Sunway, Malaysia

Correspondence
Michelle Khai Khun Yap, School of Science, Monash University Malaysia, Jalan Lagoon Selatan, 47500 Bandar Sunway, Selangor, Malaysia.
Email: yap.michelle@monash.edu

Abstract

Experiential learning is compromised in meeting the educational demands of our students during the challenging time of the COVID-19 pandemic. A more inclusive, flexible, and objective-oriented experiential learning environment is required. In this context, module-based experiential learning that is executable on a digital platform was designed. The learning module focused on protein biochemistry, contained a combination of asynchronous and synchronous activities categorized into 'Knowledge Hub' and 'Lab-based Movie', across 5 weeks. Digital and module-based experiential learning provides equitable, inclusive, and flexible access to students at remote locations. Furthermore, it is an objective-oriented and highly organized experiential learning framework that encourages students to engage and participate more in the learning process.

KEYWORDS

active learning, laboratory exercises, learning and curriculum design, teaching and learning techniques methods and approaches, using simulation and internet resources for teaching, web-based learning

1 | INTRODUCTION

Experiential education emphasizes 'learning by doing' to capture a broader and more diverse cohort of learners. It allows students to gain experience, engage, and reflect as well as develop technical and interpersonal skills for career readiness and professional upbringing.[1] In biochemistry, experiential learning is usually implemented through lab-based activities including hypotheses formulation, data collection from experimental investigation of hypotheses, and data interpretation. Amid the COVID-19 shutdowns, the way in which education is conducted has significantly changed for an indefinite time.[2] Face-to-face teaching and lab classes are suspended with drastic shifts towards long-distance and e-learning during the pandemic. This prompts a rapid decision by educators to transform from face-to-face to online learning. It provokes the need to adopt different pedagogies for new norms in teaching and learning.[3,4] I teach biochemistry to second year undergraduate students. To continue experiential learning in biochemistry, more digital hands-on approaches are incorporated into the learning environment. I selected a topic in protein biochemistry—focusing on the isoelectric point of amino acids to design a wholly digital lab-based experiential learning using virtual classroom flipping pedagogy. This digital experiential learning enables students to learn experimental skills in hypotheses formulation, data collection, interpretation, scientific writing, and communication.

2 | DESIGN AND ONLINE DELIVERY OF EXPERIENTIAL LEARNING WITH EXPERIMENTAL SKILLS

I designed a learning module on the topic "Isoelectric point of amino acids" for 5 weeks, which consisted of asynchronous and synchronous activities. This learning module contained 'Knowledge Hub' and 'Lab-based Movie' (Figure 1). In 'Knowledge Hub', a lesson plan containing bite-sized videos and student-centered workshop activity was created to provide conceptualization and performance expectations of this topic. Students performed instructional and self-directed learning in week 2. In the student-centered workshop on week 3, a live conferencing on Zoom was conducted for students to undertake team-based problem-solving activities together with live polling. The objective of 'Knowledge Hub' is to enhance students' prior knowledge of pKa and isoelectric points (pI). We began lab-based activities by having a series of movie-style activities, including trailers, real show, and movie reviews. In week 4, students were required to complete the trailers and quiz on the Guroo e-learning SCORM package (www.gurooproducer.com). Students need to score 70 points in the quiz to earn a 'movie ticket' to the real show (Figure 1).

Later in week 5, students attended the Zoom session to conduct the real hands-on activity—the real show on "Titration of Arginine" (https://sites.google.com/monash.edu/arginine/titration-of-arginine?authuser=1). This website outlines the virtual titration activity of arginine with acid and base. In this session, students were randomly assigned to different breakout rooms (small cinema halls) that were managed and led by teaching assistants. Students learned to formulate hypotheses, performed data collection and interpretation using virtual titration activities, under the guidance of teaching assistants. Students then need to apply their basic knowledge on titration and pKa to determine the isoelectric point of the amino acid, arginine. Following the completion of the real show, students submitted a movie review on week 6.

The movie review was completed using an Evernote template (Figure 2). This movie review served as a laboratory report for graded assessment. The movie review template was divided into two main sections: the results section and the analysis section. In the results section, students were required to compile the data collected from virtual titration activities and tabulate the results (Figure 2). Following data collection, students plotted the titration curve based on the data. This titration curve was used to determine the isoelectric point value of arginine,

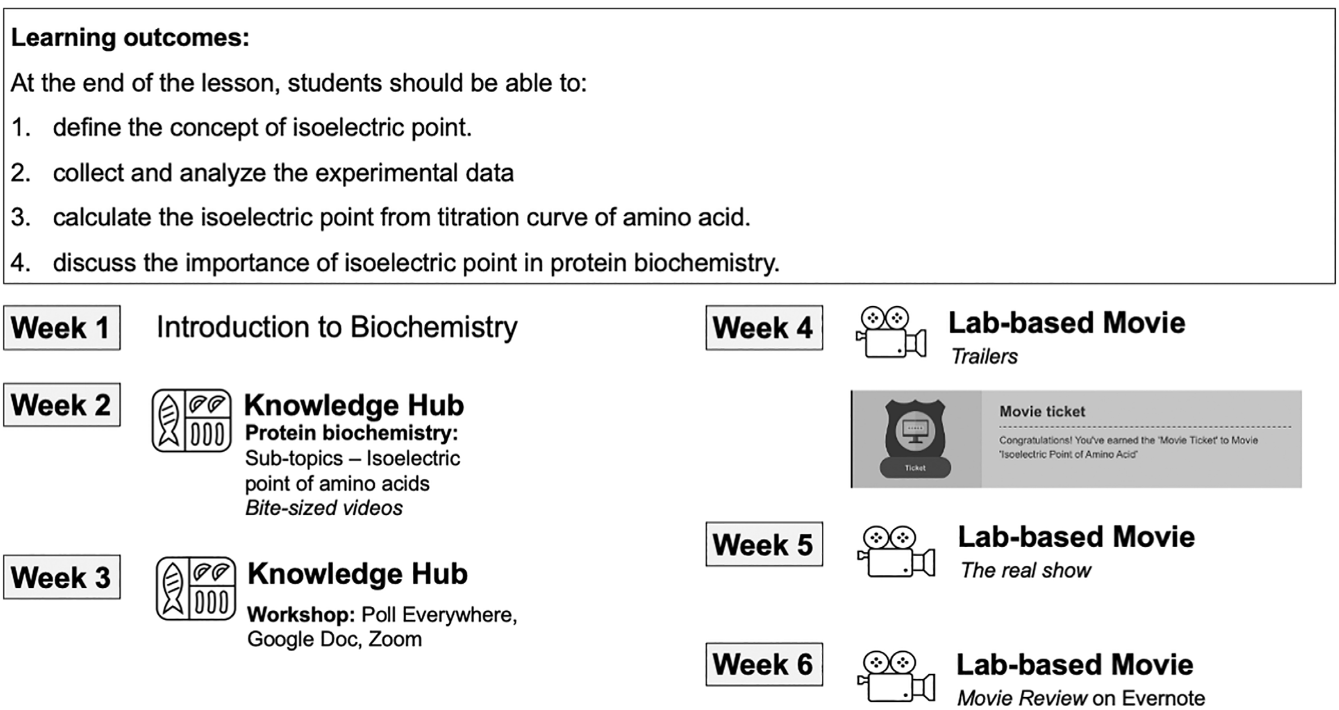

FIGURE 1 The framework of digital, module-based experiential learning of protein biochemistry on sub-topics isoelectric point of amino acids

Evernote

The isoelectric point of amino acid arginine

NAME :
STUDENT ID :

1

Instructions:

1. Complete this worksheet without amending its format and template.
2. Round off all your final answers to two decimal points, except for absorbance readings.
3. Provide in-text citations and references in the Harvard referencing style for questions required citation. Only books and/or articles are accepted.
4. Proofread before submitting.
5. Submit this worksheet to Moodle (in pdf) before the due date.

RESULTS AND DISCUSSIONS

2

Table 1: (11 m)
Provide a descriptive title

Total volume (equivalent*) of NaOH added (mL)	Total mole (equivalent) of OH- added	pH

3

Plot a titration curve of pH *vs.* total equivalent moles of OH- added for arginine. (7 m)
Format for titration curve - make sure x-axis and y-axis are correctly labeled with variables and units. Make sure the titration curve pattern is correct for the data points in the graph. Provide a descriptive title UNDER the titration curve. (4 m)
On the titration curve, you are required to annotate the pKa values i.e. label the pKa values on the curve (3 m).

4

Analysis (26 m):

1. Provide the structure of arginine at different pH as below:
   - pH< pKa_1
   - pKa_1 < pH < pKa_2
   - pKa_2 < pH < pKa_3
   - pH > pKa_3

   Relate your answer to the buffering region in the titration curve. *What happens to arginine protonation/deprotonation when the pH is > or < particular pKa* value? *Are they protonated or deprotonated?* You can hand-draw the structure for this question. If you obtain the structures from literature, remember to cite them (12 m)

2. Calculate the pI value of arginine obtained from this experiment. Include the steps of calculation. Here, you need to explain the principles behind the calculation of the pI value. (4 m)
3. Compare the experimental pI value of arginine with its theoretical pI value (How close are these two values? Is there any big gap observed? (2 m). Provide a citation of where you get the theoretical pI value.
4. Why is pH important for amino acid chemistry? (2 m)
5. Explain why amino acids have more than one pKa value? (3 m)
6. Name **ONE** technique besides titration that can be used to determine the isoelectric point of amino acid. Describe the principle behind this technique. (3 m)

Reference(s) [2 M]
Provide the reference (Harvard referencing style) for the in-text citation.

FIGURE 2 Template of movie review using Evernote. The instructions are given (1) to facilitate students to complete the review. Students are required to compile the data collected from virtual titration activity on Webpage (https://sites.google.com/monash.edu/arginine/titration-of-arginine?authuser=1) into a table (2). After compilation of data, students plotted a titration curve according to the explanation given (3). Lastly, students need to perform data analysis by answering the questions in (4). This movie review was submitted as a lab report for graded assessment in which students first annotated pKa values on the titration curve and determined pI using the equation, $pI = \frac{pKa_1 + pKa_2}{2}$. In the analysis section, several brainstorming discussions related to learning objectives have been included to encourage critical thinking among students (Appendix S1).

Students were also asked to write reflections about their learning from the digital-module-based learning activity. The analyses revealed that 73% of students said the learning activities helped them to understand the concept of pKa and pI, and 87% of students have learned how to perform data analysis by determination of the buffering capacity and pI value of arginine from the titration curve. The learning objectives of this digital module-based learning are (1) to define the concept of isoelectric point, (2) to collect and analyze the experimental data, (3) to calculate isoelectric point from the titration curve of amino acid, and (4) to discuss the importance of isoelectric point in protein biochemistry (Figure 1). The students' reflections revealed that this learning pedagogy enables them to reinforce their conceptual knowledge of pI. They were able to apply this concept to protein biochemistry. Overall, this digital module-based experiential learning achieves the learning objectives of the topic despite restricted physical access.

3 | CONCLUSIONS

In conclusion, the digital experiential learning module provides a flexible, inclusive, equitable, and objective-oriented learning environment for students during COVID-19. This digital learning module offers a more organized framework for students, in which students are still able to learn scientific skills that are applicable to their future careers. This framework of the experiential learning module can be adopted by different subjects and disciplines. The learning objectives are achieved.

ACKNOWLEDGMENT

Open access publishing facilitated by Monash University, as part of the Wiley - Monash University agreement via the Council of Australian University Librarians.

CONFLICT OF INTEREST

The author declares no conflict of interest.

ORCID

Michelle Khai Khun Yap https://orcid.org/0000-0002-9646-3944

REFERENCES

1. Kolb AY, Kolb DA. Learning styles and learning spaces: enhancing experiential learning in higher education. Acad Manag Learn Educ. 2005;4:193–212.
2. The Lancet Editorial. Research and higher education in the time of COVID-19. Lancet. 2020;396:583. https://doi.org/10.1016/S0140-6736(20)31818-3
3. Christian DD, McCarty DL, Brown CL. Experiential education during the COVID-19 pandemic: a reflective process. J Constr Psychol. 2020;34:264–77. https://doi.org/10.1080/10720537.2020.1813666
4. Mishra L, Gupta T, Shree A. Online teaching-learning in higher education during lockdown period of COVID-19 pandemic. Int J Edu Res Open. 2020;1:100012. https://doi.org/10.1016/j.ijedro.2020.100012

SUPPORTING INFORMATION

Additional supporting information can be found online in the Supporting Information section at the end of this article.

How to cite this article: Yap MKK. A digital module-based experiential learning in protein biochemistry during the COVID-19 pandemic paradigm. Biochem Mol Biol Educ. 2023;51(1): 77–80. https://doi.org/10.1002/bmb.21680