CASE STUDY

Improving the student learning experience through the student-led implementation of interactive features in an online open-access textbook

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ABSTRACT

This case study highlights the work of Students as Partners (SaP) as a balanced approach for implementing and evaluating an online open-access textbook in introductory animal physiology at the University of Toronto Mississauga. Started in 2017 with an eCampus Ontario grant, the project involved undergraduate and graduate students developing and improving an open-access e-textbook to support student learning in a second-year undergraduate introductory animal physiology course. This case study focuses on the 2019–2020 academic term and the work of two undergraduate students working alongside faculty and two librarians. As part of their research, the partners consulted the literature and gathered feedback from students taking the course in which the open e-textbook was used. Student partners added updates and new interactive features to create a more engaging educational resource to support student learning. The partners also reflected on their role in the open educational resource development process.

KEYWORDS

students as partners (SaP) in research, student perspectives, interactivity, online open-access textbook

In this case study, two undergraduate students, a faculty member, and two librarians collaborated to further develop an online open-access textbook used in a second-year introductory animal physiology course (BIO202) at the University of Toronto Mississauga (UTM). Open-access textbooks are open educational resources (OERs), which are defined as

"teaching, learning and research materials in any medium—digital or otherwise—that reside in the public domain or have been released under an open license that permits no-cost access, use, adaptation and redistribution by others with no or limited restrictions" (UNESCO, 2019). The open-access textbook used in this project was curated and developed by the faculty and librarians and published through Pressbooks by eCampus Ontario for open use in an introductory animal physiology course at the university. Here, we focus on summarizing the implementation of new interactive features in an open-access e-textbook available to all students enrolled in the course and explain how we used students' perspectives as active learners to guide this implementation.

Partnerships between students and faculty in developing educational resources can be beneficial when guided by universal design principles and grounded in students' learning experiences (Bovill,2013; Cook-Sather,2009). Universal design principles suggest that multiple means of representation can help to provide students with better access to resources (Center for Applied Special Technology [CAST], n.d.), creating opportunities for clearer connections to curriculum content for all students (Story, 1998). When students work alongside faculty and librarians, there is an opportunity to create a dynamic relationship that allows students to connect to and be represented in the curriculum materials, such as online textbooks. Students, as active learners in a course, have the potential to play an integral role in the course development process by providing unique perspectives about the use, accessibility, and efficacy of educational resources from a learning perspective.

It has been suggested that the main drivers of development or implementation of online open-access textbooks are the overall interest of educators, student financial barriers, and decisions made during the development process (Dutkiewicz et al., 2018). Instructors can guide how curriculum content is developed in an open educational resource by considering whether:

- curriculum-based content is presented visually as well as textually (Rowhani & Sedig,2005),
- interactive activities are included (Wang et al.,2011), and
- student learning preferences and preferred textbook presentation are considered (e.g., PDF, physical copy, or e-textbook) (Rockinson-Szapkiw et al., 2013).

Financial barriers also can shape educational resource development and use (Hardin et al., 2019). The creation of no-cost OERs can reduce barriers to access to make these resources available to a greater number of students. A reduction of barriers may also include making sure that internet or electronic devices are available to students who are using OERs (Asunka,2013).

INVOLVEMENT OF STUDENTS AS PARTNERS (SaP) IN THIS CASE STUDY

A SaP team updated an online open textbook resource in a research opportunity program at UTM. The faculty member in this team was also the instructor who typically teaches the undergraduate introductory animal physiology course in which the online open-access textbook was used. The open education resource development project was envisioned to provide an affordable alternative to a traditional textbook and has been tailored to reflect the course structure and materials presented in the course. This project is now in its fourth year

and has benefitted from student partnership since its inception. In the first year of development, the two librarians and the faculty member worked together as content creators, editors, and experts in the course material to curate and develop resources for the first edition of the online textbook with undergraduate students and several graduate students. This open-access textbook was created using the Pressbooks platform (an open-source content publishing tool) and was published by eCampus Ontario. Revisions were made based on student feedback on the first edition of the open e-textbook. Two undergraduate students developed new educational resources and made suggestions for improvements for this evolving open educational resource.

The student partners were integral to the completion of this research project, as they incorporated edits and new educational resources to the online open-access textbook based on literature consultation and feedback from students who were using the textbook in the animal physiology course. The students met with faculty and librarians weekly to discuss (a) published work on the interactivity of online open-access textbooks as part of the curriculum, (b) feedback from students who have used this online open-access textbook, and (c) published perspectives on the benefits and drawbacks of online open-access textbooks.

LESSONS FROM THE LITERATURE

The SaP team consulted the literature on the use of interactive features, such as animations, self-tests, and videos for student learning within online resources. Rowhani & Sedig (2005) emphasize the role of interactive features in combination with textual descriptions to better support critical thinking and connective processes. Interactive components can inspire student interest and enthusiasm (Teo et al., 2003, Dutkiewicz et al., 2018) and provide multiple means of engagement to support student motivation (CAST, n.d.). Unlike a static textbook based purely on textual descriptions and visual representations of text, interactive features in an online resource can promote active learning by encouraging students to make critical connections with textual and visual information (Saarinen et al., 2015; Swidan & Naftaliev, 2019; Mills, 2016). The implementation of interactive elements and assessment of understanding can enhance student learning and allow a better comprehension of the material (Dutkiewicz et al., 2018). Interactivity can provide learners with a more comprehensive understanding of the subject matter, as students can apply their knowledge to solve higher-level diagnostic questions (Evans & Gibbons, 2006). In addition to the importance of interactivity, research suggests that although students appreciate the portability and low- or no-cost options of online e-textbooks, four out of five students still prefer using a printed or hard copy of a textbook (Rockinson-Szapkiw et al., 2013).
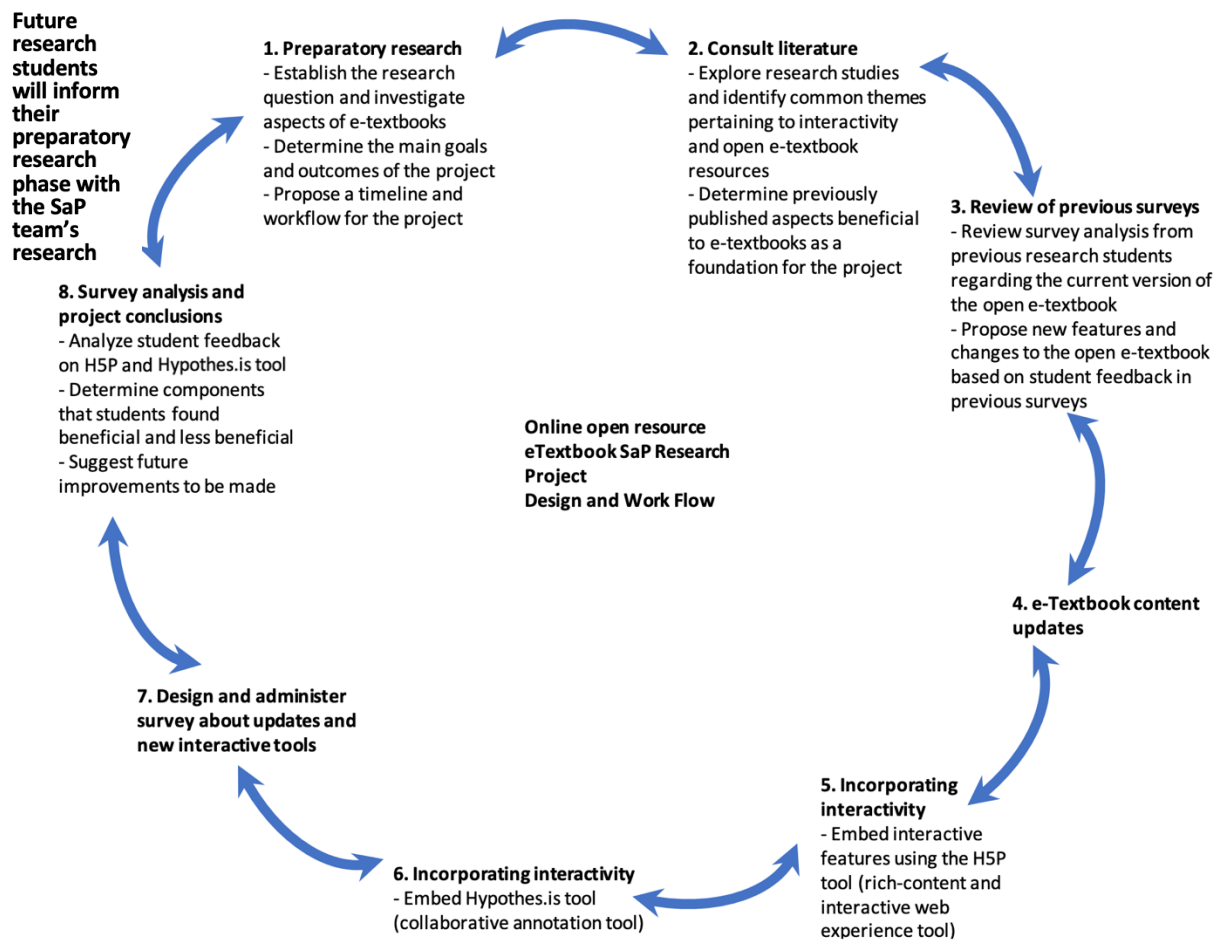
Informed by lessons from the literature, the SaP team grounded their design of the open-access online textbook in two main approaches:

- inclusion of interactive visual features (H5P tool, which is a rich interactive web content authoring tool) and
- inclusion of other alternative tools that support learning when using online textbooks (Hypothes.is tool, which is a social annotation web platform).

DESIGN APPROACH AND METHODS

The student partners identified aspects of the collaboration with the faculty member and librarians for their own professional development and used that reflection and literature to inform their goals (see Step 1 in Figure 1). Given the time constraints in a semester, each student partner reviewed between 5–10 articles within a 2-week time frame on the topic of interactivity within online resources (see Step 2 in Figure 1). The objective was to analyze articles that discuss the impact on student performance and preference for such resources. The annotated bibliographies consisted of summaries of each study, and the potential impacts on the current project were considered before making any revisions to the current online e-textbook. The faculty member and librarians reviewed the annotated bibliographies to ensure the relevance of the articles and sources. The articles were researched early in the semester so that enough time was allotted to implement textual changes and interactivity to the existing open e-textbook so that students would have an opportunity to use the resource and share their experiences in using the resource.

Guided by lessons from the literature on methods to improve student learning experiences through introducing interactive elements, the SaP team started a redesign of the online open textbook next. This redesign also was motivated by feedback from students who used the first edition of this open-access textbook and from instructors and librarians using and evaluating it. The redesign was completed using the Pressbooks platform to publish this open textbook. The student partners reflected on the work of previous research students to gather feedback on the open textbook (see Step 3 in Figure 1) to decide which textbook edits would be incorporated (see Step 4 in Figure 1). In consultation with the literature, the student partners found that H5P was reported as supportive of learning (Grönlund et al., 2018). Therefore, student partners used the H5P tools (i.e., true/false, multiple-choice highlighting, and annotation tool) to design interactive questions, which were developed by studying a specific chapter and targeting difficult concepts (see Steps 5 in Figure 1). The SaP team used the Hypothes.is tool to include highlighting and annotation features in the updated chapters of the open e-textbook to incorporate the benefits of hard-copy textbook annotations in an online environment (see Step 6 in Figure 1). This highlighting feature allows students to mark parts of the textbook that they deem important, which they can keep either as private notes or share publicly with peers.

Figure 1: Case study design and methodology

Future research students will inform their preparatory research phase with the SaP team's research

1. Preparatory research
- Establish the research question and investigate aspects of e-textbooks
- Determine the main goals and outcomes of the project
- Propose a timeline and workflow for the project

2. Consult literature
- Explore research studies and identify common themes pertaining to interactivity and open e-textbook resources
- Determine previously published aspects beneficial to e-textbooks as a foundation for the project

3. Review of previous surveys
- Review survey analysis from previous research students regarding the current version of the open e-textbook
- Propose new features and changes to the open e-textbook based on student feedback in previous surveys

8. Survey analysis and project conclusions
- Analyze student feedback on H5P and Hypothes.is tool
- Determine components that students found beneficial and less beneficial
- Suggest future improvements to be made

Online open resource eTextbook SaP Research Project Design and Work Flow

4. e-Textbook content updates

7. Design and administer survey about updates and new interactive tools

6. Incorporating interactivity
- Embed Hypothes.is tool (collaborative annotation tool)

5. Incorporating interactivity
- Embed interactive features using the H5P tool (rich-content and interactive web experience tool)

The SaP team then designed a survey focused on the assessment of the effectiveness of the newly implemented features in the open textbook (see Steps 7 and 8 in Figure 1). The survey consisted of 10 questions based on usage and experience with the newly implemented H5P interactive self-check questions and Hypothes.is tool features (see Table 1). The goal was to implement interactivity to enhance and improve the student experience with the open e-textbook and provide a way for students to become more involved in their learning. The SaP team developed the questions to assess student opinions about the potential benefits and challenges they faced when using the interactive tools as well as questions so that future improvements to the e-textbook could be made. The SaP team distributed the anonymous survey at the end of the Winter 2020 term to 457 students who were using the updated second edition of the open e-textbook (see Table 1).

Table 1. Survey questions for students using the revised open e-textbook

QUESTION NUMBER	QUESTION TEXT
1	I found that the interactive questions that provided feedback at the end of Chapters 1 and 4 were beneficial to my learning experience in BIO202. (Likert scale)
2	How were the interactive questions beneficial or not beneficial to your learning? (Short answer)
3	The questions at the end of newly updated chapters that provided feedback allowed me to test my knowledge on concepts within the chapter. (Likert scale)
4	I had technical issues when I used the interactive questions that provided feedback at the end of the newly edited chapters. (Likert scale)
5	How many times have you accessed the Hypothes.is tool throughout your learning during the course? (Multiple response)
6	How did you incorporate the Hypothes.is tools in your learning and studying purposes? (Multiple response)
7	If you selected other, please indicate other ways that you used the Hypothes.is tool. (Short answer)
8	I found the Hypothes.is tool helpful towards my studying throughout the course. (Likert scale)
9	I found the Hypothes.is software easy to navigate. (Likert scale)
10	Is there anything we didn't ask you about that you would like to tell us about the 2nd edition of the e-textbook? (Short answer)

FINDINGS FROM THE SURVEY

Student respondents found that the new interactive questions at the end of Chapters 1, 4, 8, and 9 allowed them to test their conceptual knowledge (84.4% of respondants) (Table 2). Students agreed that the interactive components were beneficial to their learning experience (77.1% of respondents) (Table 2). A total of 41.7% students found that the Hypothes.is tool was easy to navigate, and 39.5% indicated that it was helpful for studying. A large proportion of the students (47.9% of respondents) did not take a clear stand on the usefulness of the Hypothes.is tool or its navigation ease (Table 2). This may be attributed to the fact that we found that 40% of students reported never using the Hypothes.is tool (Table 1). In their survey comments, students expressed reasoning such as not knowing the Hypothes.is tool was included within the new chapter editions, needing more clarification on what the tool was, and some noted that they preferred "to make annotations in a separate document rather than directly in the open e-textbook." In response to an open-ended question (the last question in Table 1), a total of 43% of respondents mentioned that they were "satisfied" with the new tools in the online e-textbook while 44% expressed "no opinion."

Table 2: Summary of survey results

ITEM / RESPONSE	STRONGLY DISAGREE	DISAGREE	NEITHER AGREE NOR DISAGREE	AGREE	STRONGLY AGREE
	No. (%)	No. (%)	No. (%)	No. (%)	No. (%)
I found that the interactive questions that provided feedback at the end of Chapters 1, 4, 8, and 9 were beneficial to my learning experience in BIO202. (N=96)	3 (3.1)	2 (2.1)	17 (17.7)	53 (55.2)	21 (21.9)
The questions at the end of Chapters 1, 4, 8, and 9 that provided feedback allowed me to test my knowledge on concepts within the chapters. (N=96)	2 (2.1)	0 (0)	13 (13.5)	55 (57.3)	26 (27.1)
I had technical issues when I used the interactive questions that provided feedback at the end of Chapters 1, 4, 8, and 9. (N=95)	21 (22.1)	42 (44.2)	18 (19.0)	12 (12.6)	2 (2.1)
I found the Hypothes.is tool helpful towards my studying throughout the course. (N=96)	6 (6.3)	6 (6.3)	46 (47.9)	30 (31.2)	8 (8.3)
I found the Hypothes.is tool easy to navigate. (N=96)	3 (3.1)	8 (8.3)	45 (46.9)	36 (37.5)	4 (4.2)

Students who participated in the survey found the interactive questions (multiple-choice and true and false questions created by the H5P tool) beneficial for their learning (see the first two columns in Table 2). Therefore, students generally expressed interest in and enthusiasm about the interactive H5P components within the online textbook. Student respondents indicated that they found the interactive questions provided in the revised version of the online open-access textbook helpful in testing their knowledge and beneficial in support of their learning (Table 2). Our findings are in alignment with previous research regarding the benefits of increased interactivity in online open-access textbooks (Teo et al., 2003, Dutkiewicz et al., 2018, Weng et al., 2018).

As noted by the student respondents in our survey, a printed version or an offline downloadable version of the open resource should be available as an option for students. We are currently implementing options for our open-access textbook to be available in different formats such as Kindle, PDF, or iBook for students who prefer to read the textbook off-line or in print.

IMPACT ON STUDENTS, FACULTY, AND LIBRARIANS

This project was initiated in 2017 with an eCampus Ontario grant and has since involved undergraduate and graduate students to further develop and improve this online open-access

textbook at our institution. In addition to providing learning opportunities for students at our institution, we also reflect on the impact this project had on our collaboration during this case study. We found that creating collaborations between student partners, faculty, and librarians in different departments made the design of interactive elements in an online textbook feasible as more support was provided. Our collaborative process resulted in a high-quality open-access textbook that was received positively by students. Additionally, the design was further informed by the input from the students enrolled in the course who were the primary users of the resource. This form of collaboration supports implementers and researchers by addressing time constraints and helps keep resources updated and relevant for students.

Student impact
Our research provided a unique teaching and learning perspective on the benefits of a student-faculty dynamic. The student-faculty dynamic was developed as the faculty member provided support to the student partners through active discussion of the textbook material and interactive features to improve student learning in the course. The student partners played a primary role in this case study and gained knowledge through active involvement in the research methodology, data analysis, development of interactive questions, and improvements in the curriculum to enhance students' course experiences. Most critically, it is the collaboration of the student partners with faculty that resulted in successful improvements to the open-access textbook. The partnership between students, faculty, and librarians in this improvement process also provided an effective way to include voices of undergraduate students taking the introductory animal physiology course about the effectiveness of their open-access textbook.

Faculty-member and librarian impact
The faculty member and librarians were able to gain insights into how students process new information as active learners and what aspects of the curriculum may be beneficial or challenging to their learning. The faculty member and librarians could engage in an active discussion with learners about what it is like to learn new material for the first time. Through collaborations such as this, faculty members and librarians can renew their perspectives on student learning experiences and apply these renewed perspectives to the development of learning tools in a course or a program.

LIMITATIONS
We had to adjust our targets to accomplish our research goals according to the teaching schedule of the introductory animal physiology course using the open e-textbook. As a result, the student partners were not able to distribute their survey to students enrolled in the course who used the revised second edition of the textbook until the course and academic year were completed. Since they received the survey results after their own research opportunity program ended, this time limitation had an impact on the type and number of interactive components the student partners could develop during their research opportunity program.

CONCLUSION

The primary focus of this project was to improve student learning by incorporating interactive elements in an online open-access textbook for an introductory animal physiology course at the University of Toronto Mississauga. A team of students partnered with a faculty member and librarians as researchers to provide a new perspective for the process of developing course resources. This research collaboration resulted in improvements to the quality of an open-access textbook used in an anatomy and physiology course and was well received by students using the resource. Based on the study conducted by the SaP team and the positive results achieved among students using this new textbook, future research students will be inspired to build on the current project or take it in a new direction. From this experience, we recognize the value of student-led partnerships with faculty and librarians to improve learning experiences by creating and updating educational resources for learners. Through this case study, the student partners demonstrated the potential students have to act as a catalyst for learner-driven improvements to open educational resources and to inspire future collaborative work in the educational resource development process.

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REFERENCES

Asunka, S. (2013). The viability of e-textbooks in developing countries: Ghanaian university students' perceptions. *Open Learning, 28*(1), 36–50. https://doi.org/10.1080/02680513.2013.796285

Bovill, C. (2013). Students and staff co-creating curricula – A new trend or an old idea we never got around to implementing? In C. Rust (Ed.), *Improving student learning through research and scholarship: 20 years of ISL* (pp. 96–108). The Oxford Centre for Staff and Educational Development, Oxford Brookes University

Center for Applied Special Technology (CAST). (n.d.) UDL and assessment. http://udloncampus.cast.org/page/assessment_udl.

Cook-Sather, A. (2009). From traditional accountability to shared responsibility: The benefits and challenges of student consultants gathering midcourse feedback in college classrooms. *Assessment & Evaluation in Higher Education, 34*(2), 231–241. https://doi.org/10.1080/02602930801956042

Dutkiewicz, A., Kolodziejczak, B., Leszczynski, P., Mokwa-Tarnowska, M., Topol, P., Kupczyk, B., & Siatkowski, I. (2018). Online interactivity—A shift towards e-textbook-based medical education. *Studies in Logic, Grammar, and Rhetoric, 56*(1), 177–192. https://doi.org/10.2478/slgr-2018-0048

Evans, C., & Gibbons, N. J. (2006). The interactivity effect in multimedia learning. *Computers & Education, 49*(4), 1147–1160. https://doi.org/10.1016/j.compedu.2006.01.008

Grönlund, A., Wiklund, M., & Böö, R. (2018). No name, no game: Challenges to use of collaborative digital textbooks. *Education and Information Technologies, 23*(3), 1359–1375. https://doi.org/10.1007/s10639–017–9669-z

Hardin, E. E., Eschman, B., Spengler, E. S., Grizzell, J. A., Moody, A. T., Ross-Sheehy, S., & Fry, K. M. (2019). What happens when trained graduate student instructors switch to an open textbook? A controlled study of the impact on student learning outcomes. *Psychology Learning & Teaching, 18*(1), 48–64. https://doi.org/10.1177/1475725718810909

Mills, M. S. (2016). Student preference of a customized, open-access multi-touch digital textbook in a graduate education course. *Contemporary Educational Technology, 7*(2), 123–137. https://doi.org/10.30935/cedtech/6167

Rockinson-Szapkiw, A. J., Courduff, J., Carter, K., & Bennet, D. (2013). Electronic versus traditional print textbooks: A comparison study on the influence of university students'

learning. *Computers and Education, 63*, 259–266. https://doi.org/10.1016/j.compedu.2012.11.022

Rowhani, S., & Sedig, K. (2005). E-books plus: Role of interactive visuals in exploration of mathematical information and e-learning. *Journal of Computers in Mathematics and Science Teaching, 24*(3), 273–298.

Saarinen, S., Heimonen, T., Turunen, M., Mikkila-Erdmann, M., Raisamo, R., Erdmann, N., Yrjanainen, S., & Keskinen, T. (2015). Identifying user interaction patterns in e-textbooks. *Scientific World Journal, 2015*, 1–12. https://doi.org/10.1155/2015/981520

Story, M. F. (1998). Maximizing usability: The principles of universal design. *Assistive Technology, 10*, 4–12. https://doi.org/10.1080/10400435.1998.10131955

Swidan, O., & Naftaliev, E. (2019). The role of the design of interactive diagrams in teaching— Learning the indefinite integral concept. *International Journal of Mathematical Education in Science and Technology, 50*(3), 464–485. https://doi.org/10.1080/0020739X.2018.1522674

Teo, H.-H., Oh, L.-B., Liu, C., & Wei, K-K. (2003). An empirical study of the effects of interactivity on web user attitude. *International Journal of Human Computer Studies, 58*(3), 281–305. https://doi.org/10.1016/S1071–5819(03)00008–9

UNESCO. (2019). Open educational resources. https://en.unesco.org/themes/building-knowledge-societies/oer.

Wang, P.-Y., Vaughn, B. K., & Liu, M. (2011). The impact of animation interactivity on novices' learning of introductory statistics. *Computers & Education, 56*(1), 300–311. https://doi.org/10.1016/j.compedu.2010.07.011

Weng, C., Otanga, S., Weng, A., & Cox, J. (2018). Effects of interactivity in e-textbooks on 7th graders science learning and cognitive load. *Computers & Education, 120*, 172–184. https://doi.org/10.1016/j.compedu.2018.02.008