Interactive H5P content for increased student engagement in a dental hygiene program

Nazlee Sharmin*, PhD, MEd; Janki Pandya*, MDS; Thomas R Stevenson*, BSc, DDS, MSc; Ava K Chow*, PhD

ABSTRACT

Background: Presently, dental hygiene education is primarily divided into classroom lectures, simulation labs, and clinical experiences. Although the recent surge of curriculum renovation in dental and medical schools centres around enhancing student engagement and active learning, classroom teaching remains teacher-focussed, involving students mainly as passive learners. H5P is an open platform for creating and sharing interactive HTML5 learning content. A large set of H5P content was created and provided to students through the learning management system as supplementary material for an oral biology course in the dental hygiene program at a Canadian university. This study was conducted to evaluate the impact of this interactive H5P content on the students’ learning experiences. Methods: The third-year dental hygiene students enrolled in the oral biology course were invited to participate in the study. Anonymised student performance data from the summative exam were analysed, and a survey regarding the student experience with the supplementary H5P content was administered. Results: Students performed better on questions for which H5P supplements were provided. The results from the survey showed satisfaction and perceived benefit of using H5P as supplementary content in didactic lectures. Discussion: The H5P content allowed students to apply knowledge and reproduce understanding, promoting active learning in the didactic oral biology course. Students appreciated the content’s interactive nature and expressed willingness to have similar experiences in other courses. Conclusion: Using H5P, interactive learning content can promote self-directed and personalized learning. This open learning platform has the potential to redefine didactic teaching by fostering an active learning environment.

INTRODUCTION

The recent surge of curricular transformation in dental and medical schools centres on pedagogical advancements to improve students’ learning experiences. Approaches to student-centred learning include incorporating innovative teaching techniques and blending traditional teaching with technology-enhanced learning components. Most dental hygiene training programs include classroom learning, simulations, and clinical training. Although

PRACTICAL IMPLICATIONS OF THIS RESEARCH

- Classroom teaching in dental hygiene programs is usually teacher-focussed, involving students as passive learners only.
- H5P is a platform for creating and sharing interactive HTML5 learning content to foster active learning and student engagement in didactic teaching.
- The findings of this study identify H5P as a potential tool for enhancing student engagement.
Emerging technologies have been identified as beneficial for oral health professional education, with their applications being primarily limited to clinical education and simulation labs.\textsuperscript{13} Infusing technology into didactic teaching can promote active learning and student engagement.\textsuperscript{4}

To establish student-centred learning in classroom lectures, the instructional design should incorporate student engagement tools, create opportunities for students to self-reflect, and provide timely feedback.\textsuperscript{2} Several educational theories support such student-centred active learning approaches. According to cognitivism, learning can be effective when the classroom environment is adaptive, personalized, and in students’ control.\textsuperscript{4} Similarly, the constructivist approach supports student-centred, personalized learning and encourages self-regulation through engagement with the content.\textsuperscript{5,10} Technology-supported learning resources for didactic courses are considered “personalized” if students can use them at any time and location to pace their knowledge acquisition or if the technology can respond to individual students with tailored feedback.\textsuperscript{2,11}

H5P (HTML 5 Package)\textsuperscript{12} is a web-based platform that enables instructors to create, share, and collaborate on interactive teaching and learning content. Through this platform, an educator can create and share 53 types of interactive content that can be customized to suit learners’ ages and learning materials. The extensive collection of content types in H5P includes crosswords, dialogue cards, image pairing, augmented reality (AR) scavenger hunts, interactive videos, branching scenarios, dictation, finding hotspots, interactive books, virtual tours, and timelines.\textsuperscript{13} This platform also contains a community repository where previously created H5P libraries, applications, and content can be shared with peers. The interactive content can be embedded in learning management systems (LMSs) such as Canvas, Brightspace, Blackboard, and any other platform that supports embedded content (iframes). H5P also contains plugins for WordPress and Moodle, which make sharing content quick and easy for instructors.\textsuperscript{13}

The wide range of web-based content types offered by H5P enables instructors to make supplementary learning content or practice materials that students can easily access outside the classroom. Incorporating supplemental content that is created and delivered using the H5P platform in didactic teaching is supported by Bauman’s layered learning model, which describes a format for scaffolding traditional didactic teaching with technology.\textsuperscript{13,14} This model acknowledges the importance of conventional didactic learning through faculty interaction but encourages a multimodal approach to teaching, where technology is used to scaffold the transfer of knowledge.\textsuperscript{13,14}

Activities delivered via the H5P platform can foster active learning and student engagement. The Interactive Constructive Active Passive (ICAP) framework of cognitive engagement identifies 4 modes of engagement: passive, active, constructive, and interactive.\textsuperscript{13} In the passive mode, which is the simplest mode of engagement, learners acquire new information in an isolated manner, such as listening to a talk or lecture. In an active mode of engagement, learners can manipulate new information to reinforce learning. In constructive engagement, students can effectively integrate previously learned knowledge, and in the most complex interactive mode, learners can co-integrate knowledge with peers to create new knowledge pathways.\textsuperscript{2,13} The ICAP framework orders the 4 modes of engagement according to increasing complexity as passive, active, constructive, and interactive, suggesting that more complex engagement with learning materials can lead to deeper levels of learning.\textsuperscript{13} Using H5P, educators can create an active and constructive level of engagement for students, allowing them to manipulate the learning materials, self-assess their learning, integrate knowledge, and reproduce their understanding.\textsuperscript{7}

The interactive content created using the H5P platform can promote self-directed learning.\textsuperscript{14} Formative and immediate feedback provided by the H5P content enables students to self-reflect and self-assess their learning.\textsuperscript{17} Sinnayah et al.\textsuperscript{17} incorporated H5P learning activities in physiology classes at the university level. Surveys indicated that the H5P components promoted self-directed learning. Students also agreed that their knowledge of anatomy and physiology was enhanced by repeated practice with H5P activities.\textsuperscript{17} Rekhari et al.\textsuperscript{18} similarly created interactive learning components using H5P for anatomy and physiology classes. The findings of that study suggest that creating this type of H5P content can lead to a deeper understanding of anatomy and physiology and contribute to overall student success.\textsuperscript{18}

Oral Biology II (OBIL 302) is a foundational science course in the dental hygiene program at the University of Alberta, Canada. The course is taught in a traditional didactic manner, where a teacher delivers the learning materials to the students in the form of a lecture. This study aimed to develop interactive resources using the H5P platform for the oral biology course and evaluate the impact of these artefacts on the student learning experience.

Hypothesis
Although H5P has immense potential for enhancing student engagement, the application of this technology has not been studied in dentistry and dental hygiene programs. A series of H5P artefacts were created for an oral biology course offered to the third-year dental hygiene students. A study was conducted to evaluate the impact of the H5P supplementary learning content on the perceived and actual learning of the students. In line with previous studies, the current study hypothesized that:

1. The introduction of supplementary H5P content in the oral biology course would positively impact students’ academic scores.
2. Students would express a positive attitude towards and satisfaction with the supplementary H5P content.

**MATERIALS AND METHODS**

**Ethics approval**

This study was reviewed and approved by the University of Alberta Research Ethics Board (REB 2). The ethics approval ID is Pro00117742.

**Development of the H5P content**

H5P content types were reviewed to choose the most suitable formats to help students in memorization, self-assessment, and review concepts. Eighteen (18) separate H5P artefacts from 5 content types (drag and drop, drag and drop words, dialogue card, memory game, and quiz) were created for the oral biology course (Table 1).

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**H5P artefacts to help with memorization**

The Oral Biology II (OBIOL 302) course in the dental hygiene program is a foundational science course. Like most foundational science courses, OBIOL 302 requires students to memorize some facts. Examples of such content are the names of the muscles, bones or organs involved in mastication. Studies support that knowledge can be retained for longer periods when learned by repetition. Using H5P, interactive 2-sided flashcards and memory games were developed to assist students in remembering the masticatory apparatus and tooth eruption theories by repeatedly exposing them to the same information.

The content type “dialog cards” was used to create 2-sided flashcards. With this type of flashcard, one side can contain an image, clue, keywords, concept or question; the other side contains the answer. The students can click

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**Table 1. H5P content created for the OBIOL 302 course**

<table>
<thead>
<tr>
<th>Topic and learning outcomes</th>
<th>Supplementary H5P</th>
<th>Content type</th>
</tr>
</thead>
<tbody>
<tr>
<td>Bone physiology and remodelling</td>
<td>Identify bone cell locations</td>
<td>Drag and drop</td>
</tr>
<tr>
<td>Categorize the types of bone cells.</td>
<td>Identify bone cells</td>
<td>Drag and drop</td>
</tr>
<tr>
<td>Explain the steps of bone remodelling.</td>
<td>Label stages of bone remodelling</td>
<td>Drag and drop</td>
</tr>
<tr>
<td>Describe the types of bone and their function.</td>
<td>Label bone</td>
<td>Drag and drop</td>
</tr>
<tr>
<td>Microcirculation of the pulp</td>
<td></td>
<td></td>
</tr>
<tr>
<td>Identify the components of microcirculation.</td>
<td>Matching word</td>
<td>Drag and drop words</td>
</tr>
<tr>
<td>Describe the role of the components of microcirculation.</td>
<td></td>
<td></td>
</tr>
<tr>
<td>Tooth eruption</td>
<td></td>
<td></td>
</tr>
<tr>
<td>Define the major events of tooth eruption.</td>
<td>Matching word</td>
<td>Drag and drop words</td>
</tr>
<tr>
<td>Recognize the molecular mechanism of tooth eruption.</td>
<td></td>
<td></td>
</tr>
<tr>
<td>Explain tooth eruption theories.</td>
<td>Flashcards</td>
<td>Dialogue card (2-way flashcard)</td>
</tr>
<tr>
<td>Demonstrate how some theories are supported or opposed by some experimental evidence.</td>
<td></td>
<td></td>
</tr>
<tr>
<td>Biochemistry of hard tissue</td>
<td></td>
<td></td>
</tr>
<tr>
<td>Differentiate the hydroxyapatite crystals in enamel vs dentin.</td>
<td>Matching word</td>
<td>Drag and drop words</td>
</tr>
<tr>
<td>Mechanoreceptor</td>
<td></td>
<td></td>
</tr>
<tr>
<td>Describe a simple neuronal circuit.</td>
<td>Neuronal circuit: complete the diagram</td>
<td>Drag and drop</td>
</tr>
<tr>
<td>Recognize different types of reception, receptors, and channels.</td>
<td>Matching word</td>
<td>Drag and drop words</td>
</tr>
<tr>
<td>Characterize sensory adaptation.</td>
<td>Identify tonic and phasic receptors</td>
<td>Drag and drop</td>
</tr>
<tr>
<td>Mastication</td>
<td></td>
<td></td>
</tr>
<tr>
<td>Characterize the movement of the bones involved in mastication.</td>
<td>Identify jaw movements I and II</td>
<td>Drag and drop</td>
</tr>
<tr>
<td>Identify the bones of mastication.</td>
<td>Identify bones of mastication</td>
<td>Drag and drop</td>
</tr>
<tr>
<td>Identify the muscles of mastication.</td>
<td>Flashcard: mastication</td>
<td>Dialogue card (2-way flashcard)</td>
</tr>
<tr>
<td>Demonstrate the roles of different mastication apparatus.</td>
<td>Matching word</td>
<td>Drag and drop words</td>
</tr>
<tr>
<td></td>
<td>Practice quiz</td>
<td>Quiz</td>
</tr>
</tbody>
</table>

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and turn the flashcards to hide or reveal the answer. In this activity, students must report their performance by clicking either “I got it right” or “I got it wrong.” The flashcard activity tracks students’ self-reports, and in the next round, cards with previous incorrect performances will appear more frequently than cards with correct performances. Two sets of flashcards were created for the oral biology course: image-based flashcards to help students learn the mastication apparatus and text-based flashcards to help students learn the theories of tooth eruption (Figure 1A-E).

A memory game was also developed to help students learn the facial muscles involved in mastication. Similar to a traditional memory game, this activity required the students to search for image pairs, which, in this case, were particular facial muscles. Once students found a match, the name of the muscle was displayed, helping to reinforce learning (Figure 1F).

**H5P content for self-assessment**

H5P offers “drag and drop” and “drag and drop words” as separate content types. The drag-and-drop activity requires students to sort items into their proper places in a given image. For the oral biology course, several drag-and-drop artefacts were made (Table 1), in which students dragged text to label images or dragged text to place under the proper group. For example, students were asked to group bone cells according to their function and/or locations (Figure 2A-D). These drag-and-drop activities enabled students to self-assess their performances by clicking the “check” button. Students could re-attempt unlimited times by clicking the “retry” button (Figure 2A-D).

The “drag and drop words” content type was used to create matching type questions (Table 1). The activity required students to drag and assign text to their proper place in a sentence from a given set of words or phrases. The built-in “check,” “retry,” and “show solutions” options allowed students to self-assess their learning and improve by permitting multiple attempts (Figure 2E, 2F).

**H5P content for reviewing concepts**

H5P allows content creators to incorporate multiple content types in “quiz.” Practice quizzes were created for the oral biology students to review their concepts. The practice quiz included 4 types of interactive questions: multiple choice, fill in the blanks, true or false, and matching questions. The quizzes offer flexibility to students by allowing them to move between questions to change an answer if needed and check the accuracy of individual answers or all answers at the end. The quizzes were created for students only for practice; no scores were recorded for grading, and they could re-attempt as many times as they wished (Figure 3).

**Study design for H5P content evaluation**

A descriptive study design was chosen for this research. A descriptive study takes a systematic approach to describe a population, situation or phenomenon without identifying the underlying cause. In other words, this type of study can answer what, where, when, and how, but not the “why” questions. The present study aimed to describe the impact of supplementary H5P content on the students’ didactic learning experiences. Students’ performance in the summative assessment was evaluated. An anonymous survey was administered to collect data on the perceived benefit of the supplementary H5P content in didactic learning.

**Study participants**

The study participants were third-year students in the dental hygiene program at the University of Alberta who had taken the OBIOL 302 course in fall 2023. The 3-year program enrolls 43 students yearly.

**Intervention**

OBIOL 302 is a one-semester, 3.0-credit course with 37 hours of didactic lectures. This multidisciplinary course covers the physiology, biochemistry, and nutrition of oral structures. Some key topics include functions of the periodontal tissues, the temporomandibular joint, mastication, deglutition, special reflexes involving cranial nerves, receptors of the stomatognathic system, oral manifestations of metabolic disease, the physiology of pain, and the role of nutrition in the development of oral tissues. Supplementary H5P content was prepared for the students and was posted after the related lecture materials in eClass, the Moodle-based LMS used by the University of Alberta. Eighteen (18) H5P artefacts were made, covering material from 9 lecture hours. The artefacts were labeled as supplemental, and no academic grades were associated with the H5P content.

**Data collection**

Anonymised performance data of the class (N = 43) in the summative exam were analysed to evaluate students’ performance. The questionnaire used for the survey was adopted from the Instructional Materials Motivation Survey (IMMS) instrument. The link for the voluntary survey was posted in the LMS with the supplementary content. The voluntary survey contained a brief description of the study and a total of 14 questions, including the questions asking for their consent to use their response in the study. No formal invitations were sent to invite students to participate in the survey. To ensure positive sampling, the opening question of the survey asked participants if they had used the supplementary H5P content in the course. Only the participants who answered “yes” were allowed to proceed through the remaining questionnaire and submit the survey.

**Data analysis**

The difficulty indices were calculated for each question on 2 summative course exams. The difficulty index for a question refers to the percentage of students who answered that question correctly; the higher the difficulty
Figure 1. Dialogue cards and memory game created using H5P to help students memorize facts

Two types of dialogue cards were created for the OBIOL 302 course: (A, B) Text-based flashcards to learn tooth eruption theories and (C, D) Image-based flashcards to learn the mastication apparatus. (E) The dialogue card activity keeps track of student performance. In the subsequent rounds, the cards/questions that were answered incorrectly in previous attempts will appear more frequently. (F) A memory game was created using images of facial muscles and bones. When a match is found, the name of the anatomical part is revealed to students, helping them to remember while playing.
Figure 2. Drag-and-drop activities created for the OBIOL 302 course using H5P.

(A–D): In this activity, students could drag text or images to place them in the correct place. The students could check their performance by clicking “Check” and retry unlimited times by clicking “Retry.”

(E, F): Drag and drop word content type from H5P was used to create matching words for the course. This activity also offered self-assess and re-attempt options.
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The practice quiz contained 4 types of questions (activities): (A) Multiple choice; (B) Drag-and-drop words; (C) Fill-in-the-blanks; (D) True or false. This activity also offered self-assess and re-attempt options (E, F).

RESULTS
Impact of the supplementary H5P content on students’ academic performance
Students’ (N = 43) performance was evaluated in 2 summative assessments (Exam I and Exam II). For both exams, students improved their performance in questions for which supplementary H5P activities were available (p = 0.0553 and p = 0.0621 for Exam I and II, respectively), though statistical significance was not reached (Figure 4).

Student attitudes towards and satisfaction with the supplementary H5P content
Forty-four percent (44%) of the class (n = 19) responded to the voluntary, anonymous survey. Quantitative analysis of the survey data indicated high scores for all the questions, showing students’ positive attitudes towards and satisfaction with the H5P content in the oral biology course. Ninety-five percent (95%) of the study participants reported using H5P activity outside the classroom or lecture time. One hundred percent (100%) of the participants agreed or strongly agreed that the supplementary H5P...
content made learning easier and more enjoyable and positively impacted the learning experience. Ninety-five percent (95%) of the participants perceived that the H5P content helped clarify their concepts, and 100% of the participants affirmed that the H5P content enabled them to self-assess their learning (Figure 5A).

As part of the survey, students were asked to identify the features of the H5P content that were most beneficial to them. The feature that students perceived as the most helpful was the interactive nature of the content. Other features that students appreciated were the engaging quality of the content, the ability to self-assess learning, and the flexibility to use the content at any time and place. Some open-ended questions were included in the survey, asking students to offer additional comments and suggestions for future improvements. The descriptive comments showed that students found H5P content helpful for learning and appreciated it as a tool for reinforcing concepts. Some representative quotations include:

“I find it very helpful.”

“Good study tool.”

“I really enjoy the additional materials you provide as it is another way of conceptualizing the information and really helps me learn.”

“I really liked these additional material [sic] to study.”

Many students appreciated the ability to practice learning on a weekly basis. For example:

“I think it is great practice and would help my learning on a weekly basis for the future to facilitate my learning.”

Some students reported that H5P content enhanced their confidence in learning:

“These really helped me become more confident in my knowledge and review questions in ways I had not thought of.”

As suggestions for improvements, most students expressed eagerness to see more H5P content in oral biology and other courses. For example:

“The only thing I would suggest is more questions as I really enjoy it.”

“No improvement needed, just would like it for each lecture we do.”

“More of these would be helpful. Making the questions more challenging.”

“It would be helpful if the other [course] included supplementary activities … I felt more prepared for exams with extra activities.”

DISCUSSION

This study reports the development, implementation, and evaluation of interactive content in a didactic oral biology course in a dental hygiene program using the H5P platform. Eighteen (18) interactive artefacts from 5 content types were developed and made available to students as supplementary practice activities in the LMS. It was hypothesized that the H5P content would positively impact students’ actual and perceived learning. Results from the students’ academic assessments showed improved student performance in questions for which H5P supplements were provided, although the difference was insignificant. This study evaluated student performance on each question.
by comparing difficulty indices between questions. Only 24% (9 of 37) of the oral biology course lectures were supplemented with H5P content. As a result, there were fewer exam questions on content from the 9 lectures than from the other parts of the course. It is possible that, due to the low number of questions regarding knowledge that was supported by H5P, the difference in the performance did not reach significance. Although studies measuring the direct impact of H5P activities on students’ academic performance in foundational science courses are rare, Sinnayah et al.17 reported a perceived knowledge gain in physiology students from repeated use of H5P content.

The responses to the student survey were overwhelmingly positive, supporting the second hypothesis. Most of the study participants reported using the content outside the classroom to review their concepts and self-assess their learning. This finding, in line with previous studies, shows that students can interact with the content in the way that works for them, highlighting the potential of the H5P platform to support student-centred learning in didactic teaching.7,11

The findings of the current study identify H5P as a potential and effective tool for enhancing student engagement and introducing active learning in didactic teaching. The content made for the oral biology course using the H5P platform increased the time students spent after class engaging and interacting with the learning materials. This content also allowed students to apply knowledge and reinforce understanding, which are categorized as the active and constructive levels of engagement.7,11

The H5P platform also enables instructors to record student performance on a specific H5P activity and use it as a tool for formative assessment and instructional guidance. In this study, however, students’ performance and use of the H5P content were not tracked. Offering unmonitored supplementary activities allowed students the freedom and motivation to test their learning anonymously and re-attempt unlimited times to reinforce learning without consequence. As indicated by students’ comments, many of them appreciated the opportunity to assess their learning weekly and would like to see similar opportunities in all parts of the oral biology course and other courses.
Limitations
The authors acknowledge some limitations to this study. The findings of this study are based on data collected from one dental hygiene course, so their applicability may be limited to student populations similar to that of this study. No demographic data were collected from the study participants. Students' activities with the H5P-generated content were not recorded through the H5P platform or the LMS.

Future research direction
Future research should explore, compare, and contrast the impact of interactive content created through the H5P platform among different institutes and program years. Investigating the correlation between the time spent on the H5P content and students' academic performances will also be valuable.

CONCLUSION
H5P offers a wide range of templates for creating interactive content suitable for any learners and learning types. Using H5P, instructors can create learning content to promote self-directed, personalized learning. With the growing interest in online learning, activities developed in the H5P platform can be used to create interactive, self-directed online courses. With H5P, it is time to reimagine didactic teaching by fostering active learning and engagement. While this study shows that this technology is embraced by students and has the potential to improve learning, further studies are needed to investigate the impact of H5P on different domains of learning and engagement.

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CONFLICTS OF INTEREST
The authors of this study have declared no conflicts of interest.

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