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

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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.

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.

RÉSUMÉ

Contexte : À l'heure actuelle, la formation en hygiène dentaire s'appuie principalement sur des exposés en classe, des simulations en laboratoire et des expériences cliniques. Bien que la récente vague de révision des programmes d'études des écoles dentaires et de médecine soit axée sur le renforcement de l'engagement des étudiants et de l'apprentissage actif, le travail en classe reste axé sur l'enseignement par un enseignant : dans ce contexte, les étudiants sont principalement des apprenants passifs. H5P est une plateforme ouverte pour la création et le partage de contenu d'apprentissage interactif au format HTML5. Un vaste ensemble de contenu H5P a été créé et fourni aux étudiants, par l'entremise du système de gestion de l'apprentissage, à titre de matériel supplémentaire pour un cours de biologie buccale dans le cadre du programme d'hygiène dentaire d'une université canadienne. Cette étude a été effectuée pour évaluer les effets de ce contenu H5P interactif sur les expériences d'apprentissage des étudiants. **Méthodes :** Les étudiants en hygiène dentaire de troisième année inscrits au cours de biologie buccale ont été invités à participer à l'étude. Des données anonymisées sur le rendement des étudiants provenant de l'examen sommatif ont été analysées, et un sondage sur l'expérience des étudiants avec le contenu H5P supplémentaire a été mené. **Résultats :** Les résultats des étudiants étaient meilleurs pour les questions pour lesquelles du contenu H5P supplémentaire a été fourni. Les résultats de l'enquête ont révélé les avantages perçus de l'utilisation du contenu H5P supplémentaire dans les cours didactiques, ainsi que la satisfaction en la matière. **Discussion :** Le contenu H5P a permis aux étudiants d'appliquer les connaissances et de reproduire la compréhension, favorisant ainsi l'apprentissage actif dans le cadre des cours didactiques de biologie buccale. Les étudiants ont apprécié la nature interactive du contenu et se sont dits prêts à répéter l'expérience dans le cadre d'autres cours. **Conclusion :** Grâce à H5P, le contenu d'apprentissage interactif peut favoriser l'apprentissage autodirigé et personnalisé. Cette plateforme d'apprentissage ouverte a le potentiel de redéfinir l'enseignement didactique en favorisant un environnement d'apprentissage actif.

Keywords: education; learning; self-assessment; teaching; teaching method
CDHA Research Agenda category: capacity building of the profession

INTRODUCTION

The recent surge of curricular transformation in dental and medical schools centres on pedagogical advancements to improve students' learning experiences.[1,2] Approaches to student-centred learning include incorporating innovative teaching techniques and blending traditional teaching with technology-enhanced learning components.[3] Most dental hygiene training programs include classroom learning, simulations, and clinical training. Although

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emerging technologies have been identified as beneficial for oral health professional education, their applications are primarily limited to clinical education and simulation labs.[4,5] Infusing technology into didactic teaching can promote active learning and student engagement.[6]

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.[7] 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.[8] Similarly, the constructivist approach supports student-centred, personalized learning and encourages self-regulation through engagement with the content.[9,10] 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.[7,11]

H5P (HTML 5 Package)[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.[12] 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.[12]

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.[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.[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.[15] In the passive mode, which is the simplest mode of engagement, learners acquire new information in an isolated manner, such as when 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.[7,15] 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.[15] 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.[7]

The interactive content created using the H5P platform can promote self-directed learning.[16] Formative and immediate feedback provided by the H5P content enables students to self-reflect and self-assess their learning.[17] Sinnayah et al.[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.[17] Rekhari et al.[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.[18]

Oral Biology II (OBIOL 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).

H5P artefects 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.[19] 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

Table 1. H5P content created for the OBIOL 302 course

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

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.[20,21] 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.

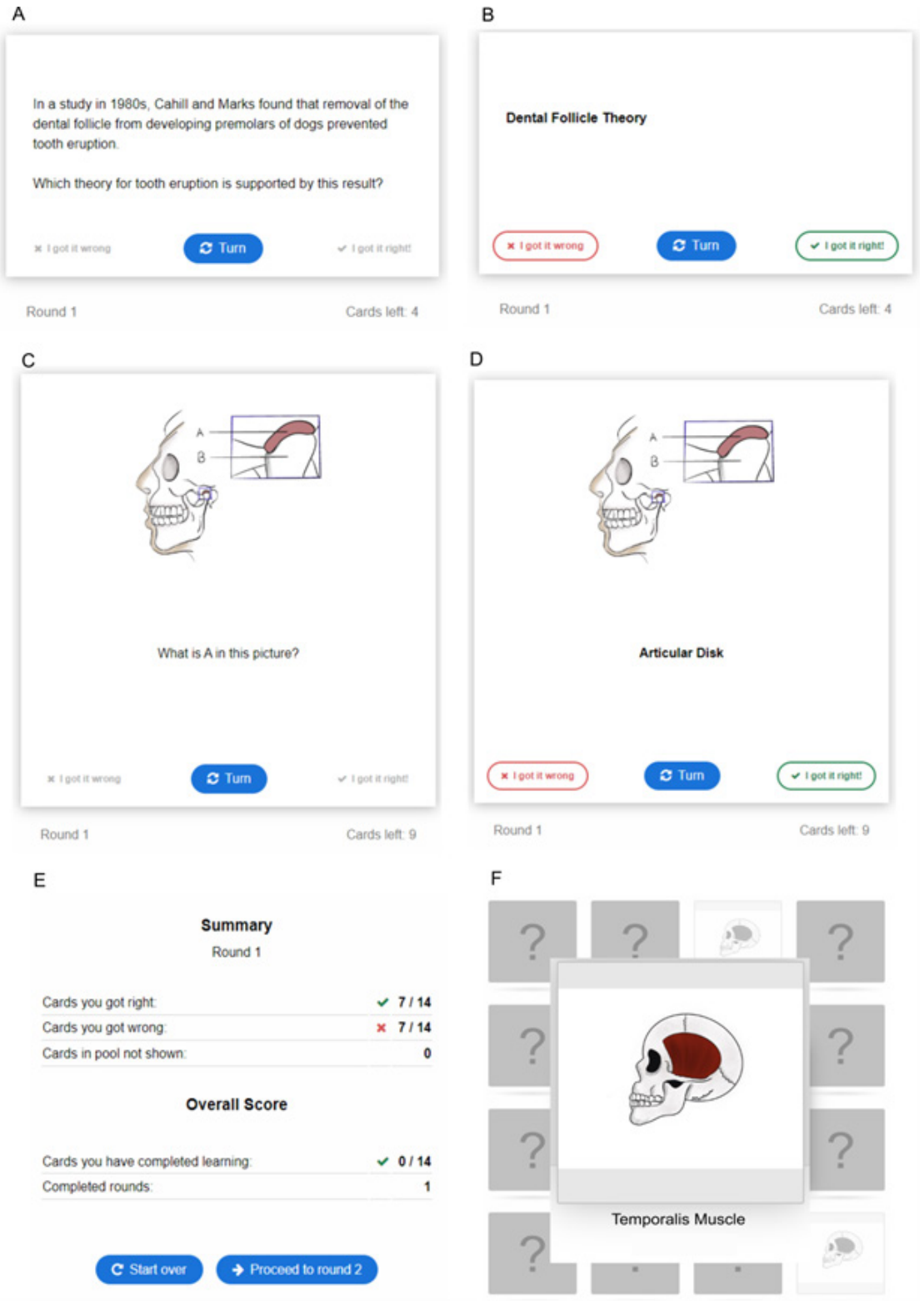
Data collection

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.[22] 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

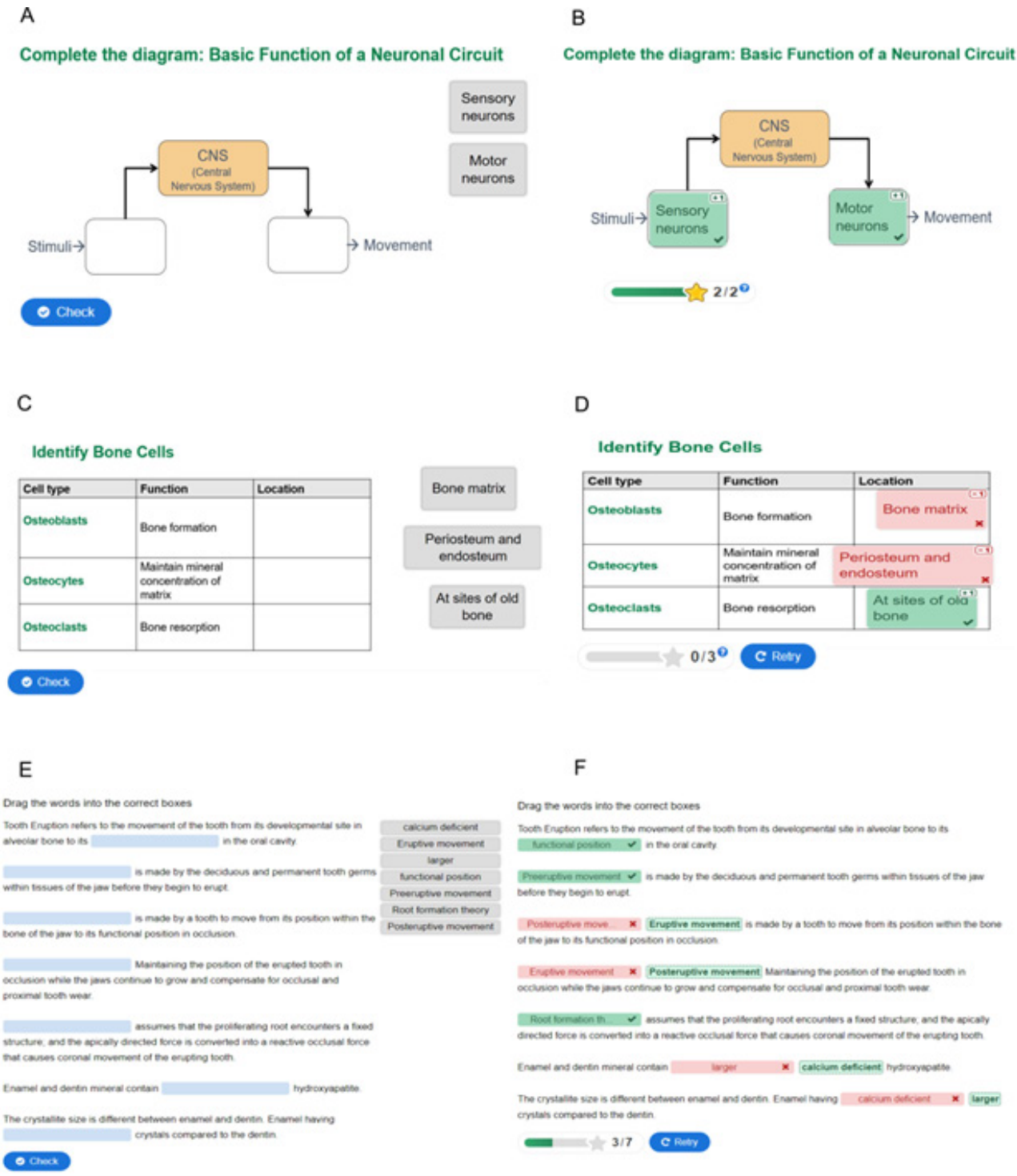
The difficulty indices were calculated for each question on 2 summative course exams. The difficulty index for a question refers to the percentage of students who answered that question correctly; the higher the difficulty

Figure 1. Dialogue cards and memory game created using H5P to help students memorize facts



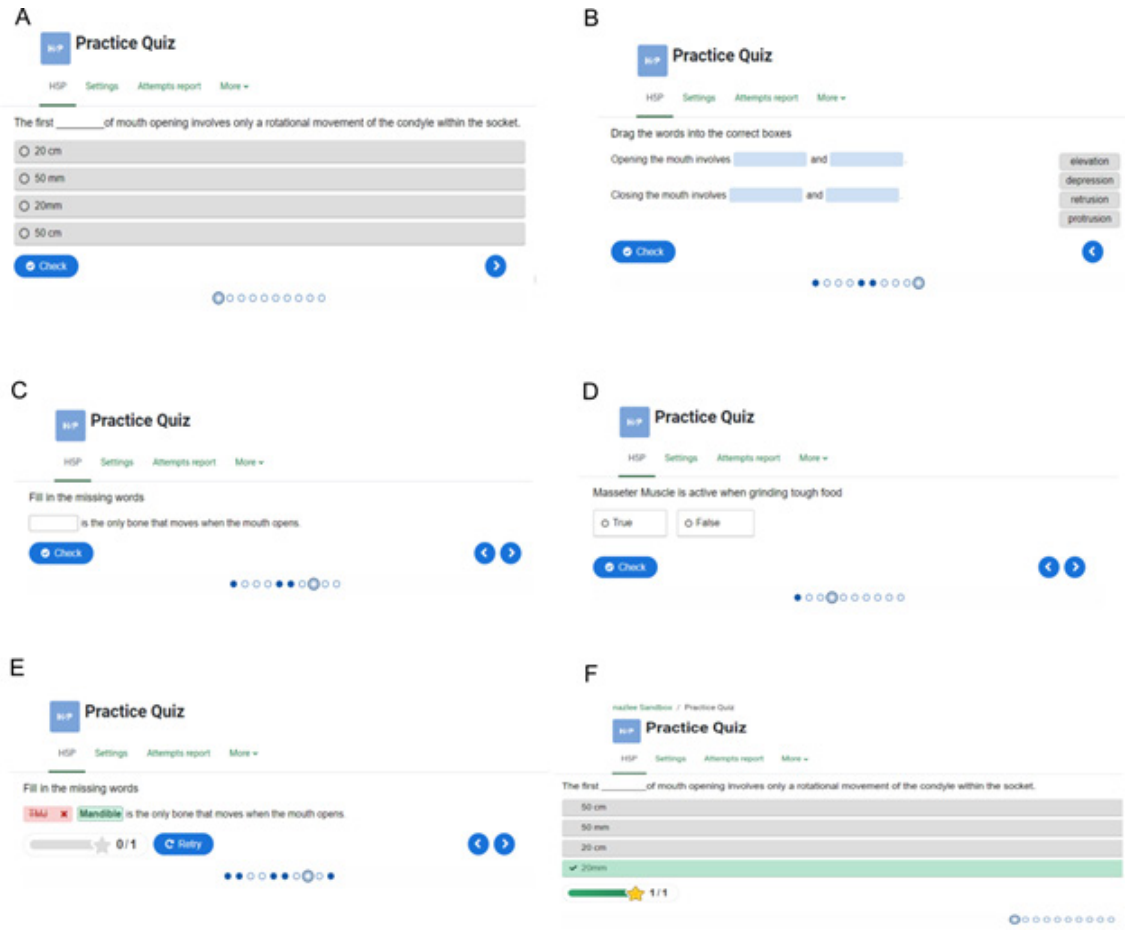
Two types of dialogue cards were created for the OBIOL 302 course: (A, B) Text-based flashcards to learn tooth eruption theories and (C, D) Image-based flashcards to learn the mastication apparatus. (E) The dialogue card activity keeps track of student performance. In the subsequent rounds, the cards/questions 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.

Figure 3. Practice quiz created using H5P for the OBIOL 302 course



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).

index score, the better the overall class performance on that particular question.[23] The summative course exams were invigilated and closed-book; students did not have access to their learning materials (and H5P activities) during the exams. The questions were a combination of multiple choice, image identification, and short answers. The questions were of 2 types: A) questions from concepts/lectures that had supplementary H5P content posted in the LMS and B) questions from concepts/lectures that had NO supplementary H5P content posted in the LMS. The difficulty indices were compared between the 2 sets of questions. Statistical analyses (2-tailed t-tests) with significance defined as $p < 0.05$ were performed using Microsoft Excel.

For the quantitative survey, each question was scored on a Likert scale from 1 to 5. The mean score was calculated for each question. The descriptive comments were reviewed to further understand students' experience, perceived benefits, and suggestions for improvements.

RESULTS

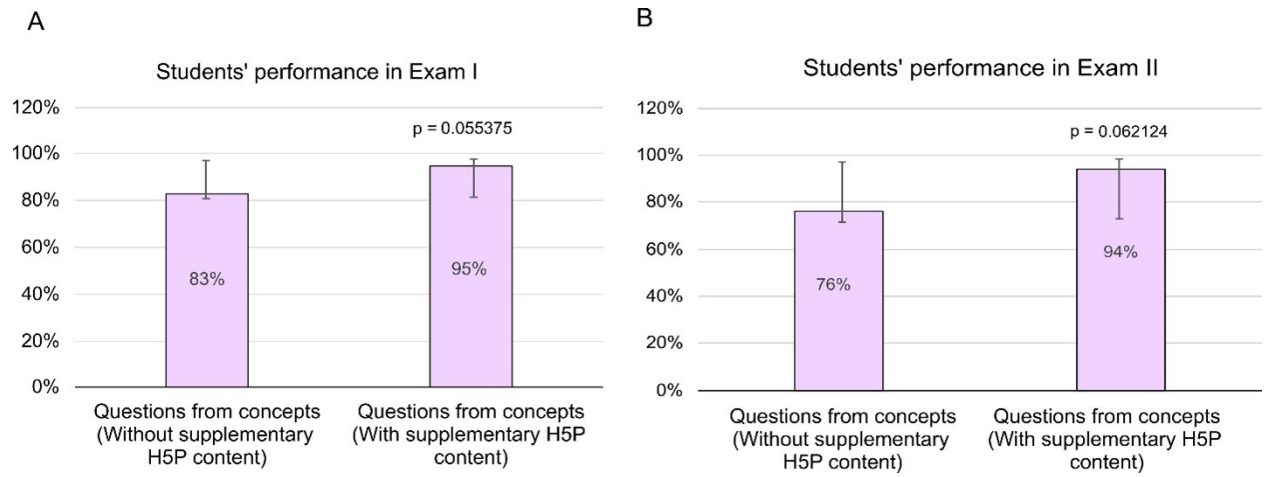
Impact of the supplementary H5P content on students' academic performance

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

Figure 4. Students' performance in Exam I (A) and Exam II (B) in the OBIOL 302 course (N = 43)



The difficulty indices—the percentage of the students who answered a question correctly—were compared between the 2 sets of questions. In Exam I, the average difficulty index for questions (without supplementary H5P content to reinforce the concept) was 83%. In the same exam, the average difficulty index for questions related to the concept reinforced by H5P supplementary content was 95%. The average difficulty indices for each set of questions appear in the bars.

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 practise 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."*

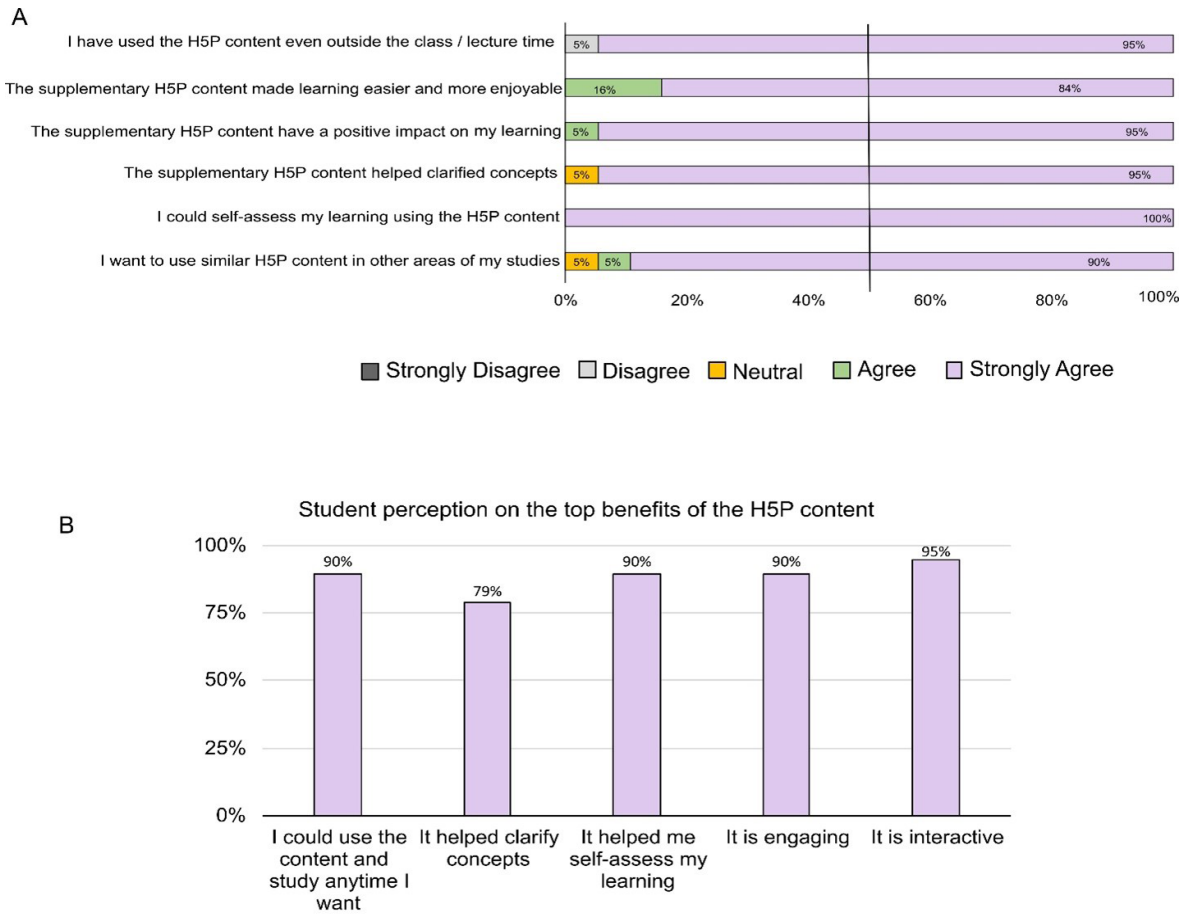
As suggestions for improvements, most students expressed eagerness to see more H5P content in oral biology and other courses. For example:

> *"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

Figure 5. Student survey reponses (n = 19)



(A) Percent distribution of students' responses; (B) Features of the interactive H5P content most appreciated by the students

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.[7,15]

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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