EdTech Cache: A database of interactive learning content for dental education and beyond

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Running Title: Database of interactive learning content

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ABSTRACT

Introduction: There is a growing interest in educational innovations across higher education. However, instructors' lack of knowledge, motivation, and concerns about extra efforts challenge the implementation of educational innovations. Open Educational Resources can promote educational innovations; however, their availability and use in dental education are minimal. **Description:** A large set of interactive digital learning artefacts were made by the authors for dental students. These learning content are curated and archived in a database, EdTech Cache, which is freely available worldwide. 46% of the content of EdTech Cache is focused on biochemistry, 28% on oral biology, and 23% on biomedical foundations. **Discussion:** Students can filter the database based on subject area and keywords to find learning activities to supplement their studies. Instructors can also use EdTech Cache to create an interactive and engaging classroom experience. **Conclusion:** EdTech Cache can benefit students and educators across health sciences education.

Keywords: database; dental education; education; educational techniques; interactive learning; learning; self-assessment; teaching; teaching materials

CDHA Research Agenda category: capacity building of the profession

INTRODUCTION

The student population in higher educational institutes is currently predominated by the post-millennial generation, born between 1996 and 2012.[1] This fast-paced, technology-native generation is interested in flexible, self-directed, and technology-infused learning.[1-3] To cope with the needs of the new generation of students and the rapidly changing environment of higher education, many higher educational institutes worldwide are welcoming educational innovations,[4] dental and medical schools are no different.

The term 'educational innovation' incorporates anything new that instructors can integrate into their teaching to improve students' learning experiences.[5] Although technology plays a crucial role in educational innovations, it is much more than simply integrating information and communication technology in teaching.[4] Wong[6] categorizes teaching innovations into two groups: those heavily relying on advanced technologies and those not necessarily involving advanced technologies. Online learning, flipped classrooms, and simulations are categorized as technology-dependent educational innovations. In contrast, active learning and interdisciplinary collaboration between students are identified as non-technology-dependent educational innovations.[6] According to Roger's Diffusion of Innovation model,[7] an educator must take sequential steps to adopt a teaching innovation, which includes knowledge acquisition, persuasion, decision-making, implementation, and confirmation. Teachers' lack of required knowledge, motivation, and concerns about extra efforts have been identified as critical challenges in implementing educational innovations.[6]

Educators need pedagogical support and collaborative environments to develop and practice teaching innovations.[8,9] Open educational resources (OER) can potentially change teaching and learning practices and drive teaching innovations.[10,11] OER are teaching and learning materials residing in a public domain, allowing no-cost access, use, adaptation, and redistribution by users.[12] Besides the widely known benefits of OER for educators and students, reports on the development and use of OER in dental education are scarce,[13] with few available ones being years old.[14]

Interactive digital content created through the H5P platform can meet the demands of the next generation of students. Using this platform, educators can make 54 different types of creative and innovative digital learning content for their students and make them available through the learning management system (LMS). Instead of a traditional lesson, instructors can create interactive course presentations, videos, or branching scenarios to provide students with interactive, self-directed learning opportunities and gamify their experiences. Educators can also make teaching and learning materials in the form of crosswords, scavenger hunts, interactive books, or dialog cards.[15] The positive impact of H5P-generated content is well-documented. Interactive H5P content can promote self-directed[16,17] and self-paced learning,[18] knowledge acquisition, and student satisfaction[17,18] while being time-consuming for instructors to make.[18] Although some Canadian universities have a resource hub for H5P content[19], it is not entirely open for public use and collaboration with other higher educational institutes.

In this context, we have developed EdTech Cache by curating interactive digital learning content for dental education. EdTech Cache can be accessed at https://edtechcache.com/ and is available worldwide for free.

PROJECT DESCRIPTION

The steps of database development included the following steps:

Development of interactive digital learning content

The authors are the faculty members of Mike Petryk School of Dentistry at the University of Alberta. The authors developed a large number of H5P interactive learning content as teaching and learning materials for the students studying in the Doctor of Dental Surgery (DDS) and Dental Hygiene (DH) program and posted in the learning management system (LMS) as supplementary learning materials. Lumi Education was used to develop the H5P content.[20] For each content created, the .h5p file was downloaded and saved on a computer.

Content curation and chart development

For each H5P content, a chart was developed, including information on the content type, subject area, key concept, learning outcomes, course, and program name where the content was or can be used. The citations for the information and images used to develop the content were also included in the chart.

Incorporation of the digital learning content into EdTech Cache

The sets of curated H5P content were incorporated into the database EdTech Cache. The user interface of the database was created on WordPress CMS (version 6.6.2), with PHP (version 8.2.16). CSS coding was used to create the template pages, and PHP was used to build the search and filter functions. Elementor and Elementor Pro plugins were installed to ensure the compatibility of the user interface across different devices. A secure sockets layer (SSL) certificate and other security plugins were installed to enhance the database security. A cloud hosting service is used to host the website contents and to ensure a seamless user experience. The steps of database development are outlined in Figure 1A.

RESULTS

EdTech Cache is freely available worldwide at https://edtechcache.com/. At the current phase, this database has the following key features:

Large collection of interactive learning content

EdTech Cache contains 90 interactive learning content, including 40 drag and drop, 25 drag the word, 13 dialog cards, 4 quizzes, 3 crosswords, 2 memory games, 2 fill-in-the-blanks, and 1 image sequencing activity. The ‘drag and drop’ activity enables students to drag and sort texts or items into their proper places in a given image. This activity was used to develop many questions asking students to label images, sort items based on their structures and functions, or order events or steps in the correct order. Drag the word type activities were used to develop matching type questions where students can drag texts from a given set of words or phrases and place them in their proper place in a sentence. Dialog cards are two-sided flashcards, enabling students to hide and reveal questions and answers with a single click. Quizzes are made of sets of interactive

questions. Crosswords and memory games are like traditional games aimed to gamify students' learning experiences. In crosswords, the hints are related to educational material; in the memory game, the card contains images from educational materials. Fill in the blanks requires students to write the missing word in a sentence. In image sequencing activities, students must sequence a given set of images in the correct order in a short time.

46% of the content (n=41) is focused on biochemistry, 28% on oral biology (n=25), 23% on biomedical foundations (n=21), and the rest on pediatric dentistry (3%, n=3). Biochemistry content was designed for a 2nd year Dental Hygiene course concentrating on protein, DNA, cells, membrane, metabolic pathways, chemical structures, stereoisomerism, and thermodynamics. The oral biology content covers a wide range of topics, including anatomy, physiology, and development of tooth, bone, and face, mastication, oral microbiology, antibiotics, and antibiotic resistance. The interactive learning content from the biomedical foundations aimed to reinforce students' concepts of cellular structure, membrane, DNA, protein, metabolic pathways, microbiology, bone physiology, and homeostasis. The concepts of genetics and epigenetics were covered under pediatric dentistry.

An easy-to-navigate interface

EdTech Cache is designed to offer an interactive and easy-to-navigate platform for students and instructors (Figure 1B). The website is indexed with Google and Bing to enhance worldwide accessibility. The dynamic EdTech Cache is optimized to suit a variety of displays and devices (Figure 1C). By clicking on the 'browse the database; tab on the header menu, the user can view the complete list of the interactive content with brief information on content type and subject area.

The list is displayed as six content per page distributed over 15 pages for comfortable viewing and navigation (Figure 2A). When an artefact is clicked, the detailed page of that artefact opens where users can interact with the content of the artefact and get detailed information on its learning outcomes, key concepts, and source of information (Figure 2B).

Search and filtering options

Users can search EdTech Cache in two ways to find content that interests them: (i) by filters and (ii) by keywords. Four built-in filters are available on the 'Browse the Database' page, enabling users to filter the artefacts by content type, subject area, Dentistry program (DDS, DH) and course name (Figure 3A). EdTech Cache also contains free-text search options for simple, quick searches. On the 'Search the Database' page, users can write free text on the search box to extract content related to that search term. (Figure 3B, 3C)

DISCUSSION

Interactive learning content created through the H5P platform can allow students to learn, review, and reinforce concepts in a fun and engaging manner. Although the benefits of H5P learning content are well-known, its widespread use in dental and medical education is yet to be achieved. The time commitment to developing such learning content can be demotivating for many instructors. EdTech Cache aims to bridge this gap by offering a comprehensive collection of interactive learning content that can benefit instructors and students.

EdTech Cache is freely available worldwide. This database can be an excellent resource for students to supplement their didactic learning of basic science concepts. Students studying at the DDS and DH programs at the University of Alberta can filter the database based on their program and/or course name. Students outside of the University of Alberta can also benefit from this resource hub by filtering the database by subject areas or searching the database with keywords. Each artefact provides references for textbooks or source materials, encouraging interested students to learn more about the subject area.

Instructors, even outside of dental education, can use EdTech Cache as a readily available teaching toolbox to create interactive and engaging student experiences in their classrooms. Each H5P content opens in a unique link that can be shared with students in class, posted in the LMS as supplementary activities, or incorporated into online courses to gamify students' learning experiences. The H5P content included in EdTech Cache is largely from foundational-level science, like biochemistry, genetics, anatomy, physiology, and microbiology, making the platform relevant across a wide range of scientific disciplines. Each learning artefact includes clearly defined learning outcomes and source of information, allowing instructors to use the free-text search feature of the database to find content that aligns with their specific teaching objectives. In addition, sources of images and information used to create the artefact are also included, enabling and inspiring instructors to create similar content to practice teaching innovations.

EdTech Cache offers a comprehensive set of interactive H5P learning content focusing on various basic science concepts taught and learned by many other health and bioscience disciplines. Many artefacts created to teach biochemistry are also usable in different courses. For example, the

concepts of cells, membranes, proteins, enzymes, and DNA are taught in multiple courses of the DDS and DH programs. This large and diverse collection of learning content can benefit students and educators beyond dental and medical education.

We acknowledge some limitations of EdTech Cache that we are committed to improving in the future. The content in this database is not uniformly distributed across disciplines, which are influenced by faculty expertise. There is a low number of content focusing on oral microbiology, pediatric dentistry, and genetics. The availability of content types in the current database is also limited. In the future, we plan to increase the collection of EdTech Cache by incorporating diverse types of H5P learning content. The functionality of the database will be monitored regularly, and the content and citation will be updated on a yearly basis.

CONCLUSION

EdTech Cache is a platform for students to get an engaging, self-paced learning experience. Instructors can use EdTech Cache as a first step in practicing teaching innovation in the classroom. We believe this OER can help students and educators across many disciplines in health sciences education.

Practice Implications:

- The availability and application of Open Educational Resources (OER) in dental education are minimal.
- EdTech Cache, a freely available database of interactive learning content, can benefit students and educators across health sciences education.

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REFERENCES

1. Schwieger D, Ladwig C. Reaching and retaining the next generation: Adapting to the expectations of Gen Z in the classroom. *Information Systems Education Journal.* 2018;16(3):45.
2. Hendrastomo G, Januarti NE. The Characteristics of Generation Z Students and Implications for Future Learning Methods. *Jurnal Kependidikan: Jurnal Hasil Penelitian dan Kajian Kepustakaan di Bidang Pendidikan, Pengajaran dan Pembelajaran*. 2023;9(2):484-96.
3. Jallad ST, Işık B. Transitioning nursing students' education from traditional classroom to online education during the COVID-19 pandemic: A case study applied to the Meleis Trial. *Florence Nightingale Journal of Nursing*. 2021;29(1):124.
4. Marisol EC. Didactic trends and perceived teachers' training needs in higher education: A case study. *International Journal of Cognitive Research in Science, Engineering and Education*. 2019;7(3):71-85.
5. Center for Teaching Innovation. Teaching Innovations at Cornell. Cornell University [website]. 2024. [cited 2024 Sep 21]. Available from: https://teaching.cornell.edu/teaching-resources/teaching-cornell-guide/teaching-cornell-getting-started/teaching-innovations
6. Wong TM. Teaching innovations in Asian higher education: perspectives of educators. *Asian Association of Open Universities Journal*. 2019;13(2):179-90.
7. Rogers EM, Singhal A, Quinlan MM. Diffusion of innovations. InAn integrated approach to communication theory and research 2014 (pp. 432-448). Routledge.

8. Androutsos A, Brinia V. Developing and piloting a pedagogy for teaching innovation, collaboration, and co-creation in secondary education based on design thinking, digital transformation, and entrepreneurship. *Education Sciences.* 2019;9(2):113.
9. Perkins Nerlich A, Soldner JL, Millington MJ. Inter-university collaboration for online teaching innovation: An emerging model. *Rehabilitation Research, Policy & Education.* 2012;26(4).
10. Coughlan T, Pitt R, Farrow R. Forms of innovation inspired by open educational resources: a post-project analysis. *Open Learning: The Journal of Open, Distance and e-Learning.* 2019;34(2):156-75.
11. Casserly CM, Smith MS. Revolutionizing education through innovation: Can openness transform teaching and learning. Opening up education: The collective advancement of education through open technology, open content, and open knowledge. 2008:261-76.
12. Hewlett Foundation. Open educational resources. [website]. 2018. [cited 2024, Sep 21]. Available from: https://www.hewlett.org/strategy/open-educational-resources/
13. Luebbers J. An Exploratory Data Analysis Study of Open Education Resources in Dental Hygiene Education.2020.
14. Davis LG, Winstanley RB, Duffin R, Griffiths A. Dental education resources on the Web. *Eur J Dent Educ.* 1998;2(1):19-24.
15. H5P. Create, Share and Reuse Interactive HTML5 Content in Your Browser. [website]. 2023. [cited 2024, Sep 25], Available from: https://h5p.org/
16. Unsworth AJ, Posner MG. Case Study: Using H5P to design and deliver interactive laboratory practicals. *Essays in Biochemistry*. 2022;66(1):19-27.

17. Sinnayah P, Salcedo A, Rekhari S. Reimagining physiology education with interactive content developed in H5P. *Advances in Physiology Education*. 2021;45(1):71-6.
18. Stevenson TR, Chow AK, Houshyar S, Sharmin N. Interactive case-based learning modules for asynchronous dental education. *J Dent Educ*. 2024. doi: 10.1002/jdd.13595.
19. eCampusOntario H5P Studio. [website]. [cited 2024, Sep 25]. Available from: https://h5pstudio.ecampusontario.ca/
20. Lumi Education. Make education accessible, individual and exciting. [website]. 2024. Ohrum, Germany. [cited 2024, Sep 30]. Available from: https://lumi.education/en/

Figures

Figure 1. (A) Steps of developing EdTech Cache, a database of interactive learning content for dental education. **(B)** Screenshot of the homepage of EdTech Cache. **(C, D)** The user-interface is optimized to suit a variety of displays and devices.

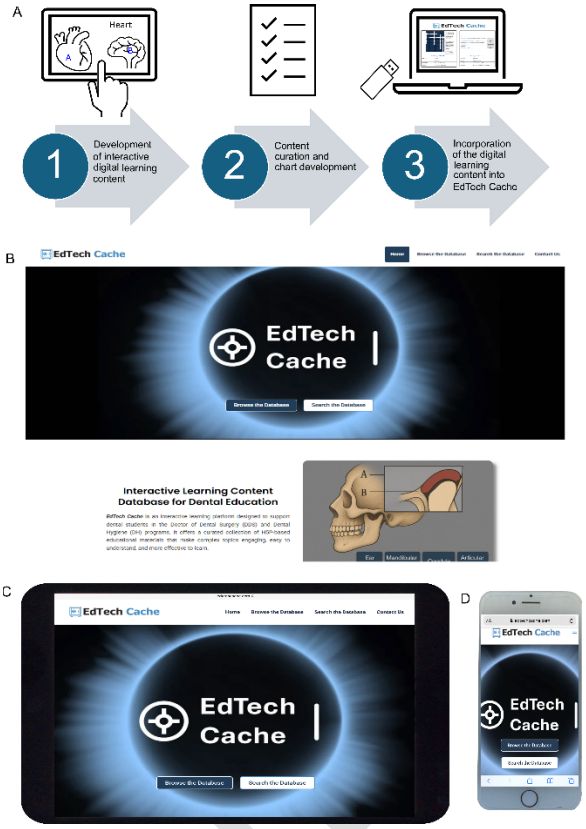
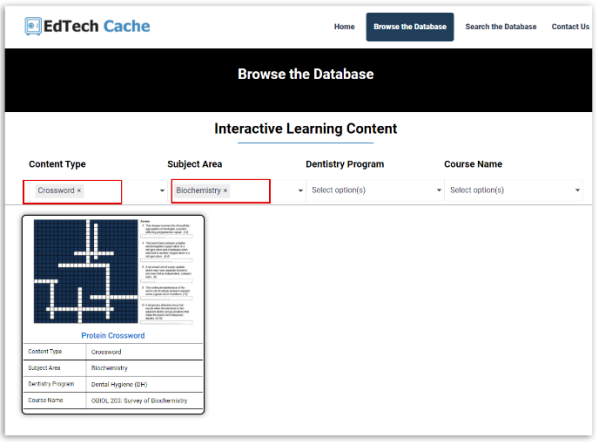


Figure 2. (A) 'Browse the database' page of EdTech Cache. This page presents the complete list of the interactive content in the database. The list is displayed as six content per page distributed over 15 pages. **(B)** Detailed page of specific content. When clicked on a content, the detailed page of that content opens where users can interact with the content and get detailed information on its

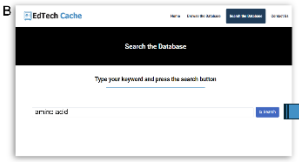
learning outcomes, key concepts, and source of information. Each content opens with a unique URL that can be shared with students and posted in the learning management system (LMS).

Figure 3. (A) EdTech Cache contains four filters to conduct specific searches. Multiple filters can be selected and applied to make the result more specific. For example, specifying content type as 'crossword' and subject area as 'Biochemistry' only one result was obtained. **(B, C)** Search the database page of EdTech Cache. Users can search the database with any keywords. Typing 'amino acid' in the search bar returned 7 results, different types of interactive content focused on amino acids.

A



B



C