Live quiz games to teach nutrition in a dental hygiene program: a pilot study

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ABSTRACT

Introduction: Higher educational institutions increasingly focus on incorporating games to enhance student engagement. Gimkit is a recent addition to gamified learning that allows instructors to create quiz games with randomly repeated questions. **Case description:** The study of nutrition requires memorization of facts. Gimkit was incorporated into a dental hygiene class to teach nutrition and support rote learning. Anonymous data on student performance and satisfaction were collected. Descriptive statistics were applied to summarize the survey results; the difficulty and discrimination indices were analyzed to evaluate students' academic performance. **Results:** Ten percent of the class participated in the voluntary survey; academic performance was analyzed for the whole class. The study identified Gimkit as a potential learning tool, especially for content areas that require memorization and learning of facts. **Conclusion:** Data show a positive impact of in-class gaming on knowledge acquisition and retention.

RÉSUMÉ

Introduction : Les établissements d'enseignement supérieur se concentrent de plus en plus sur l'intégration de jeux pour renforcer l'engagement des étudiants. Gimkit est un ajout récent à l'éventail d'outils d'apprentissage ludique qui permet aux instructeurs de créer des jeux-questionnaires avec des questions répétées au hasard. **Description de cas :** L'étude de la nutrition nécessite de mémoriser des faits. Gimkit a été intégré à un cours d'hygiène dentaire pour enseigner la nutrition et favoriser l'apprentissage par mémorisation. On a recueilli des données anonymes sur les résultats et la satisfaction des élèves. On a eu recours à des méthodes de statistique descriptive pour résumer les résultats du sondage; les indices de difficulté et de discrimination ont été analysés pour évaluer le rendement universitaire des étudiants. **Résultats :** Dix pour cent des étudiants qui suivaient le cours ont répondu à ce sondage facultatif; on a analysé le rendement universitaire de l'ensemble de la classe. L'étude a établi que Gimkit était un outil d'apprentissage potentiel, en particulier dans les domaines qui nécessitent l'apprentissage et la mémorisation de faits. **Conclusion :** Les données montrent une incidence positive de l'utilisation des jeux dans le cadre du cours sur l'acquisition et la rétention des connaissances.

Keywords: education; education, dental; knowledge acquisition; learning; motivation; perception
CDHA Research Agenda category: capacity building of the profession

INTRODUCTION

The correlation between oral health and nutrition is well established.[1] The Centers for Disease Control and Prevention (CDC) has recommended nutritional counselling to help address the rise in chronic diseases resulting from nutrition and lifestyle choices in the United States.[2] Although effective dietary counselling in an oral health setting can improve oral health, dental hygienists do not actively offer dietary advice on a regular basis.[3] A study of 987 dental hygienists and oral health therapists identified multiple barriers preventing the delivery of dietary advice. Practitioners' perceived lack of knowledge on nutrition is one of them.[3]

In the Commission on Dental Accreditation (CODA) standards, nutrition is listed as a foundational subject area.[4] However, studying nutrition differs from many branches of science because of the large volume of facts that students are expected to memorize. At the University of Alberta School of Dentistry, in the dental hygiene program, students study nutrition as a part of an oral biology course. Ten hours of didactic lectures are allocated to nutrition and its impact on oral health. Some learning outcomes of this course that require rote memorization are as follows:

- Describe the function of vitamins, minerals, and other nutrients in maintaining systemic and oral health.
- Recognize the clinical signs and symptoms of nutritional deficiencies.
- Name and recognize specific nutritional health risks associated with particular nutrient overdose.

In the oral biology course, dental hygiene students learn nutrition in a traditional, didactic manner from textbooks and lectures. Passively learning new facts places a heavy cognitive load on the students.

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A growing number of higher educational institutions are incorporating games to enhance student engagement. Gamification refers to using or adopting game mechanics, techniques, and game theory in a non-game environment, such as education.[5] Gimkit (www.gimkit.com/)[6] is a recent addition to gamified learning. Using this platform, instructors can create trivia quizzes. The instantly generated code by the host allows students to enter live games from a laptop or smartphone without having an account or registration. In-game credits are awarded for correct answers; credits are lost for each incorrect answer. Credits can be used to invest in score-boosting power-ups and upgrades that help a student get ahead of others. A live leaderboard keeps the students engaged and highly motivated. Quiz questions are randomly repeated during the game, helping students to learn and practise facts without realizing it.

Many health professional education courses have successfully applied gamification.[7,8] Online games such as Kahoot have been shown to increase student satisfaction, motivation, and collaboration.[7] A scoping review of randomized controlled trials conducted among health science students reported positive impacts of gamification on knowledge acquisition, motivation, and satisfaction.[9] The current study's authors used Gimkit to create and play digital quiz games in an oral biology class to teach nutrition. This study aimed to assess the impact of gamified teaching within the dental hygiene program. The specific research questions were as follows:

1. What is the impact of live quiz games on knowledge acquisition?
2. What is the impact of live quiz games on students' learning experience?

Bauman's layered-learning model was used as a theoretical framework for this study. This model describes a format for scaffolding multimedia technology around traditional didactic teaching.[10] Although this model acknowledges the importance of conventional didactic learning through reading and faculty interaction, it encourages a multimodal approach to teaching, where technology is used to reinforce the transfer of knowledge.[10]

CASE DESCRIPTION

A descriptive study was conducted to examine the impact of live quiz games on the students' learning experience. This study was reviewed and approved by the University of Alberta Research Ethics Board, REB2 (ID: Pro00124923).

The study was conducted among the 42 students of the Oral Biology II (OBIOL 302) course in fall 2022. This 3.0 credit course is divided into 3 parts, each tested with a non-cumulative exam. The last part of the course is focused on "Nutrition and its impact on oral health". Gimkit was introduced to students at the beginning of the course, and they played the live quiz game twice in the

Table 1. Impact of live quiz game on retention of information

Question–wise performance of students in the live quiz game (Gimkit)		
Question	% Accuracy (first game, played on Lec2)	% Accuracy (second game, repeated on Lec3)
Q1	95	100
Q2	95	100
Q3	92	98
Q4	84	85
Q5	88	84
	% Accuracy (first game, played on Lec5)	% Accuracy (second game, repeated on Lec7)
Q6	50	75
Q7	55	65
Q8	23	55
Q9	36	71
Q10	44	67
Q11	68	72
Q12	100	89
Q13	84	71
Q14	80	77
Q15	50	44

first part of the course. The game was played regularly (at least once a week) in the third part of the course in November 2022 to teach nutrition. No games were played in the second part of the course. The quiz questions focused on the materials taught in previous classes (Table 1). The duration of each game session was between 8 and 12 minutes. The games contained 14 to 38 questions prepared by the course instructor.

To determine if playing the game might help students retain information, some questions were intentionally repeated between games played a few days apart. In exam III, 12% of the questions were previously used in a game session, and 20% were based on information learned during in-class gaming. Figure 1 summarizes the details of the course pattern and the design of the intervention.

Gimkit was run in the class in an anonymous mode. Student performance data were collected after every game session to evaluate the impact of gaming on the retention of facts. Once the course ended, students were invited to participate in an anonymous, voluntary online survey in December 2022. The questionnaire was adopted from the Instructional Materials Motivation Survey (IMMS) instrument.[11] Each survey question was scored on a Likert scale from 1 to 5. Descriptive statistics, which included mean and standard deviations, were compiled to summarize the survey results using Microsoft Excel.

Figure 1. Course structure and intervention design

OBIOL 302: Oral Biology II						
	Part I	Exam I (Class average)	Part II	Exam II (Class average)	Part III	Exam III (Class average)
Weeks	5		5		4	
Lecture hours	14	76.68%	13	78.94%	10	80%
Game sessions	2		0		5	

OBIOL 302: Part III										
	Week 11		Week 12			Week 13			Week 14	
Lecture number	Lec1	Lec2	Lec3	Lec4	Lec5	Lec6	Lec7	Lec8	Lec9	Lec10
Intervention (Live quiz game)		Gimkit	Gimkit		Gimkit		Gimkit			Gimkit
Intervention time		12 min	8 min		12 min		12 min			12 min
Question content of the game session		Q from Lec1 New questions	Q from Lec1 and Lec2 New and previously used questions		Q from Lec3 and Lec4 New questions		Q from Lec3 to Lec5 New and previously used questions			Q from Lec6 to Lec10 New questions
Number of questions in exam III (from each lecture)	5	5	5	5	5	5	5	5	5	5
Number of questions in exam III (with information learned in Gimkit)	2[a]	2[a]	1[a] 1[b]	1[a] 1[b]	1[a] 1[b]	2[a]	2[b]	1[a]	0	1[b]

[a]Questions required application of information previously learnt in the game session.
[b]Questions were previously used in the game session.

Note: Oral Biology II is a 3.0 credit course divided into 3 parts, each tested with a non-cumulative exam. In part III, live quiz games were played at least once a week for 8 to 12 minutes each time. The time of the game (intervention) was set by the time available after lecture. Questions were intentionally repeated between games. In exam III, 12% of the questions were previously used in a game session, and 20% were based on information learned during in-class gaming.

The descriptive comments were reviewed to understand students' experience, perceived benefits, and suggestions for improving the gaming experience. The difficulty and discrimination indices were calculated for each question on the summative exam.

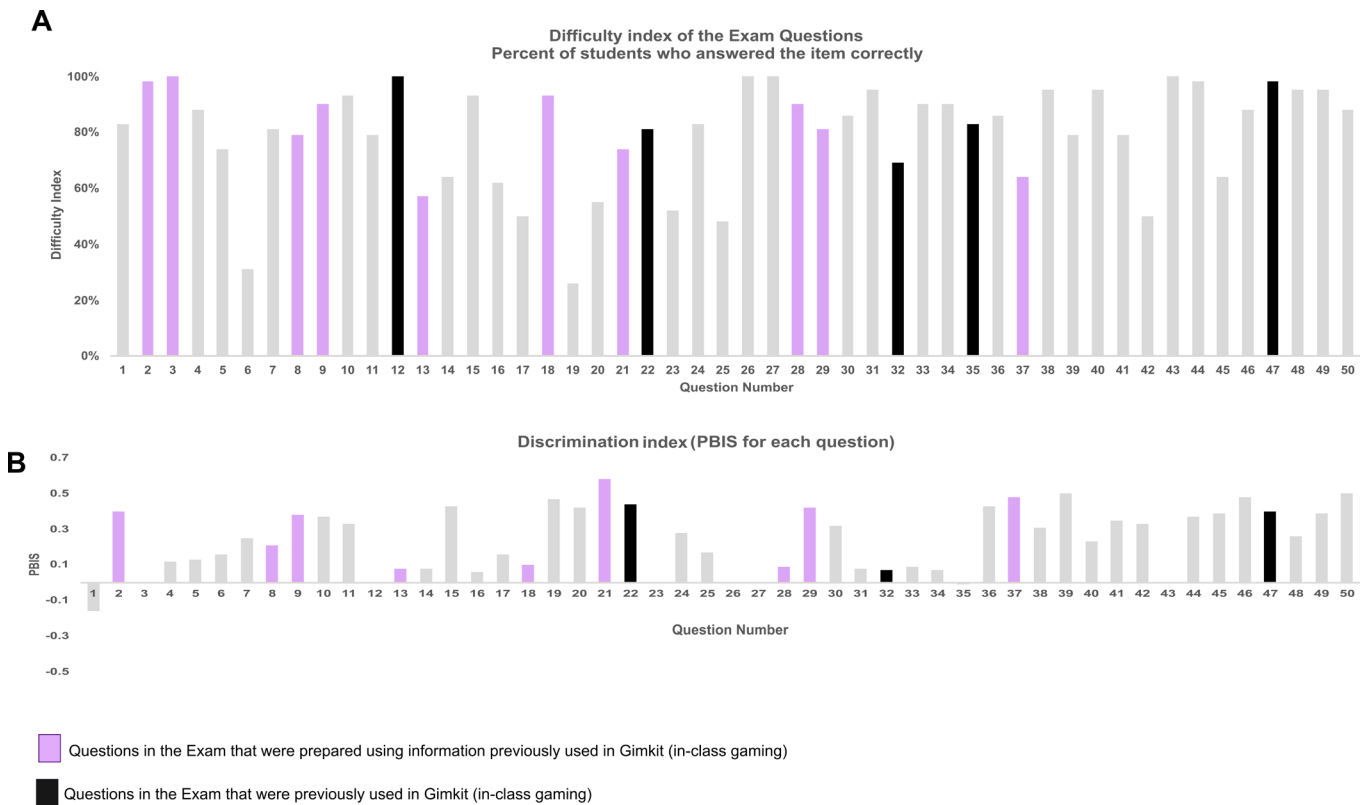## RESULTS
Knowledge retention
The percent accuracy of each question in a gaming session was collected. Higher accuracy was observed for questions repeated on the next lecture day. Five questions from game 1 were repeated in game 2, which was administered 4 days later. In 4 of 5 repeated questions, percent accuracy was between 85% and 100%, which was higher than in the previous session (Table 1). A similar approach was taken between games 3 and 4, where 10 questions from game 3 were repeated in game 4. Six of these ten questions showed an increase in percent accuracy (Table 1).

Performance in the examination
Students (N = 42) attended the final exam of the course 15 days after their last class and game session. The average for exam III was higher than the previous 2 exams in this course (Figure 1). In exam III, 12% of questions were previously used in game sessions. Twenty percent (20%) of the questions were based on information the students

Figure 2. Students' (N = 42) performance in exam III

A

Difficulty index of the Exam Questions
Percent of students who answered the item correctly

B

Discrimination index (PBIS for each question)

■ Questions in the Exam that were prepared using information previously used in Gimkit (in-class gaming)

■ Questions in the Exam that were previously used in Gimkit (in-class gaming)

Note: Academic performance was assessed for the whole class (N = 42). **A:** The difficulty index refers to the percentage of the test-takers who answered the item correctly. **B:** Point Biserial Correlation (PBIS) for each question was used as the discrimination index. This index differentiates high-ability examinees from low-ability examinees. PBIS values range from –1.0 to 1.0.

learned and were tested on during in-class gaming. Difficulty and discrimination indices were analyzed for each exam question (Figure 2). The difficulty index refers to the percentage of the test-takers who answered the item correctly.[12] The discrimination index, Point Biserial Correlation (PBIS), correlates student performance on the item and performance on the entire test.[12]

Perceived benefit of in-class gaming

Ten percent of the class (n = 4) participated in the survey. The survey invitation was sent after the course final exam on December 22, 2022. The low response rate to the survey may be attributed to the fact that students were on winter break when the invitation was sent. Nonetheless, the survey data reveal high scores for all questions, showing a positive impact of playing in-class games on all 4 components of motivation (Figure 3). Seventy-five percent of survey participants admitted to learning while playing the live quiz game. All participants (100%) agreed that playing the game helped improve their exam scores. The descriptive comments showed that some students enjoyed playing the game and described the experience as engaging and motivating. Some examples of participants' comments are as follows:

I enjoyed playing these games as it motivated me to show [up] to class.

The use of Gimkit in classes enhanced my learning, helped me keep up with my studies, and kept me engaged in class. It was an enjoyable experience.

However, some participants identified difficulties and suggested playing in groups rather than as individuals.

...I had some trouble figuring how to use Gimkit and stopped using it halfway through the course. There were too many repeat questions. Maybe make sure everyone plays so it's more fun and engaging...

DISCUSSION

This study aimed to assess the impact of in-class gaming on students' overall learning experiences. The results

Figure 3. Summary of students' (N = 4) responses to the anonymous survey

Students' response on the anonymous survey
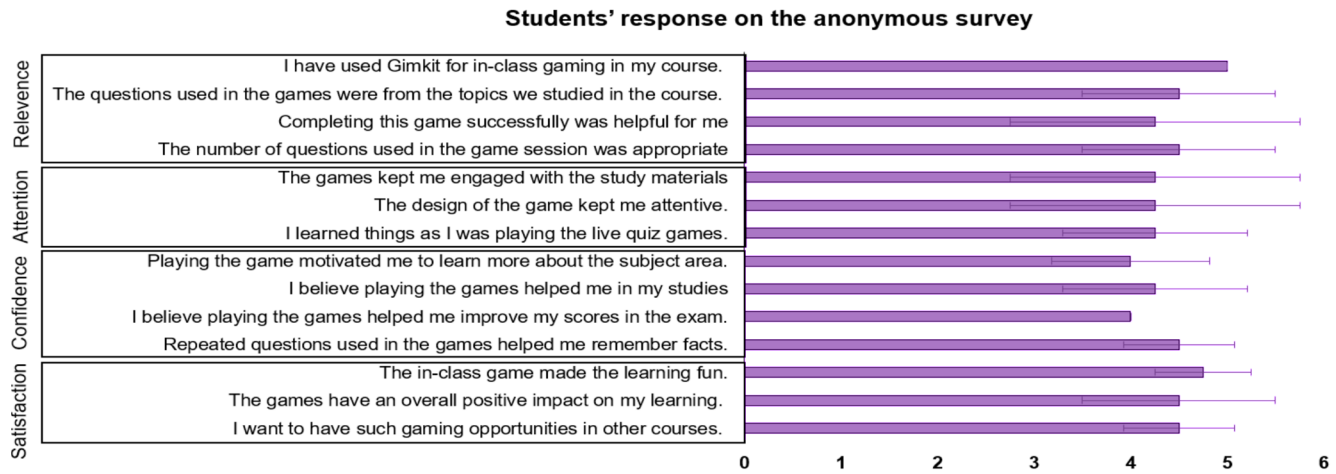
Note: The survey questionnaire was adopted from the IMMS instrument[11] developed to measure attention, relevance, confidence, and satisfaction. The bar represents the average of the Likert score (1 = strongly disagree; 5 = strongly agree) for each question.

show a positive effect of in-class gaming on knowledge acquisition and retention. In the examination, questions created using information previously known to students through Gimkit showed a higher percentage in difficulty index, indicating that a higher number of students were able to answer these items correctly. The PBIS scores for the Gimkit-based questions were relatively lower than the rest, indicating that low-performing or low-achieving students also performed well on the items/knowledge learned through in-class gaming (Figure 2).

Although the findings indicate a positive impact of in-class games on knowledge acquisition and retention, it is essential to be mindful of the voluntary and anonymous nature of the gaming platform and the secondary data obtained. After the regular lecture, students were invited to play Gimkit for approximately 10 minutes. Gimkit has the option to create nicknames for the participants when an anonymous mode is chosen. Several students often decided to join as a group and play collectively under the same name. Although many students joined to play enthusiastically and liked to compete for a top position on the live leaderboard, not all students completed the game. Some left a few minutes before the game ended. Some reasons for this behaviour could be that the students were more interested in learning the questions than in participating in the game, had difficulty figuring out the controls of the game or were unwilling to reveal their knowledge in front of the class. Although nicknames were generated, students could see and identify players if they sat beside each other. Gimkit generates a report on the students' performance after each live session. However, data are generated only for the participants who actively participate and finish the game. Because of the anonymous nature of the data, it was not possible to follow individual performance and improvement over time.

The quantitative survey collected data on motivation and the overall gaming experience using the IMMS instrument.[10] Studies on motivational theories and students' learning[13,14] identify an individual's goals for tasks, task value, and the learning environment as the key factors shaping students' motivation. According to constructivist theory,[15,16] students actively construct new knowledge when they engage in a perceived valuable and meaningful learning task.[17] Based on the survey results and narrative comments, the in-game goals and live leaderboard created by the Gimkit platform can motivate students. The real-time nature of the quiz game also generates friendly competition in the classroom, creating a motivating environment for many students. The survey results have identified positive impacts on students' learning experiences. However, a large standard deviation indicates variability in opinions for some questions related to the number of questions used per game session and the game's design (game mode). Gimkit offers multiple game modes, which were used in different game sessions. It is possible that the variability in the game modes created barriers for some students who may have had difficulty with the changing controls and goals of the games. Further studies are needed to identify students' opinions on different aspects of Gimkit.

This pilot study identified Gimkit as a promising learning tool, especially for content areas that require memorization and learning of large numbers of facts. The findings reveal some possible barriers that may prevent some students from participating in the live in-class games. Focus groups or individual interviews may help to identify precisely what these potential barriers are.

CONCLUSION

Higher educational institutions are progressively moving towards technology-infused learning curricula. These

institutions can incorporate frameworks such as Bauman's layered-learning model for designing active learning procedures. This study showed that the introduction of gamification in a dental hygiene course positively impacted students' measured and perceived learning. Gamification platforms such as Gimkit can be effective teaching and learning tools to complement traditional lectures and provide additional scaffolding for students.

CONFLICTS OF INTEREST

The authors declare that they have no competing interests.

REFERENCES

1. Touger-Decker R, Mobley C, Academy of Nutrition and Dietetics. Position of the Academy of Nutrition and Dietetics: oral health and nutrition. *J Acad Nutr Diet.* 2013;113(5):693–701.

2. Centers for Disease Control and Prevention, National Center for Chronic Disease Prevention and Health Promotion. Social Determinants of Health Community Pilots [Internet]. 2022 [cited 2023 Jan 3]. Available from: www.cdc.gov/chronicdisease/ about/ index.htm

3. Hayes MJ, Wallace JP, Coxon A. Attitudes and barriers to providing dietary advice: perceptions of dental hygienists and oral health therapists. *Int J Dent Hyg.* 2016;14(4):255–60.

4. Commission on Dental Accreditation. Accreditation Standards for Dental Hygiene Education Programs [Internet]. 2020 [cited 2022 Dec 14]. Available from: https://coda.ada.org/standards

5. Deterding S, Sicart M, Nacke L, O'Hara K, Dixon D. Gamification. Using game-design elements in non-gaming contexts. In: *CHI '11 Extended abstracts on human factors in computing systems.* Proceedings of the CHI Conference on Human Factors in Computing Systems, Vancouver, BC, Canada, May 7–12, 2011. pp. 2425–2428.

6. Gimkit [Internet]. 2020 [cited 2023 Jan 3]. Available from: www. gimkit.com

7. Felszeghy S, Pasonen-Seppänen S, Koskela A, et al. Using online game-based platforms to improve student performance and engagement in histology teaching. *BMC Med Educ.* 2019;19(1):273.

8. El Tantawi M, Sadaf S, AlHumaid J. Using gamification to develop academic writing skills in dental undergraduate students. *Eur J Dent Educ.* 2018;22(1):15–22.

9. Arruzza E, Chau M. A scoping review of randomised controlled trials to assess the value of gamification in the higher education of health science students. *J Med Imaging Radiat Sci.* 2021;52(1):137–46.

10. Bauman EB. Games, virtual environments, mobile applications and a futurist's crystal ball. *Clin Simul Nurs.* 2016;12:109–114.

11. Keller JM. *Motivational design for learning and performance: The ARCS Model approach.* New York (NY): Springer; 2010.

12. Yudkowsky R, Park YS, Downing SM, eds. *Assessment in health professions education,* 2nd ed. New York (NY): ImprintRoutledge; 2019.

13. Deci EL, Ryan RM. A motivational approach to self: Integration in personality. In: Dienstbier R, ed. *Nebraska symposium on motivation 1990: Perspectives on motivation,* Vol 38. Lincoln (NE): University of Nebraska Press; 1991. pp. 237–88.

14. Pintrich PR, Schunk D.H. *Motivation in education: Theory, research and applications,* 2nd ed. Englewood Cliffs (NJ): Merrill Company; 1996.

15. Mintzes J, Wandersee JH, Novak JD. *Teaching for understanding — A human constructivist view.* San Diego (CA): Academic Press; 1998.

16. Von Glasersfeld E. Cognition, construction of knowledge and teaching. In MR Matthews, ed. *Constructivism in science education.* Dordrecht: Kluwer Academic; 1998.

17. Hsiao-Lin T, Chi-Chin C, Shyang-Horng S. The development of a questionnaire to measure students' motivation towards science learning. *Int J Sci Educ.* 2005;27(6):639–54.