Games as homework to promote student engagement in an asynchronous online course

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Running Title: Games as homework

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ABSTRACT

Introduction: Asynchronous online courses are designed to offer flexibility. To promote student engagement, we have incorporated game-based homework assignments in an online dental hygiene course. **Description of case:** A study was conducted to describe student engagement and the impact of this intervention. Student performance data from summative exams and engagement data from the learning management system were analyzed. Results showed that students were highly engaged with the game-based assignments the week before the course summative exams. Students performed significantly better on questions reviewed by the homework assignments compared to the other questions of the exam. **Discussion:** Although the results are from one cohort of students, they demonstrate the potential of game-based homework to significantly improve students' learning experiences. **Conclusion:** The increased popularity of online and hybrid learning necessitates the innovation of new techniques to engage students online; Gimkit can be a powerful and fun tool for this purpose.

Keywords: education; educational activities; educational technique; learning; teaching; teaching method;

CDHA Research Agenda category: capacity building of the profession

INTRODUCTION

Active engagement with study materials promotes learning.[1,2] Recent studies have identified games as an effective tool to increase student engagement and knowledge retention in health science education.[3] Although most educational games are internet-based and played on the computer, they are primarily used in in-person classes.[4] For online courses or online components of blended courses, gamification is still mostly limited to the incorporation of game elements, like badges, to enhance students' learning experiences,[5] with limited reports on game-based learning designed solely for the asynchronous online course.[6]

Online learning is gaining popularity in health professional education across the world.[7] Asynchronous online courses are specially designed to provide flexibility and self-directed learning; however, engaging students in asynchronous online courses is challenging, with online discussion forums and student groups being some of the few known tools for this task.[8] Online quiz-based games from Gimkit can be a new tool to promote student engagement in asynchronous online courses.

Gimkit is an online platform (www.gimkit.com/)[9] for creating quiz-based games. Using this platform, instructors can import pre-made question banks or create question banks from scratch by including multiple-choice (MCQ), True/False, or short-answer questions. Questions can include audio and images as well. Once the question set is made, the instructor can convert it into a game-based homework assignment by setting goals for the players to achieve. Gimkit offers

four game-based homework modes for instructors to choose from: Fishtopia, Don't Look Down, Cash Tycoon, and Farmchain.[9]

'Fishtopia' is a strategic fishing game where students must answer questions correctly to get bait for fishing and then sell the fish to earn game money. The assignment is completed once the cash goal (set by the instructor) is achieved. Students can strategically invest game money to buy boosters to help them achieve the goal faster. To achieve the goal, students must go through the question sets multiple times, which allows them to reinforce concepts and memorize facts. 'Farmchain' is based on a similar theme: students grow crops and sell them to reach the cash goal. In 'Cash Tycoon' mode, students must maintain a streak of answering questions correctly to earn the game money. The wrong answer to a question makes them lose game money and credits. In 'Don't Look Down,' students earn energy by answering questions. The energy is invested in jumping and reaching a height goal the instructor sets. Fixed due dates can also be set for these game-based assignments.

Game-based pedagogies can foster a student-centered learning environment. Of the four major learning theories, both humanism and constructivism support the importance of learner-centered education[10]; however, identifying one suitable theory is difficult, as the nature of the educational game and game-based learning varies widely. The use of game-based homework assignments in education can be supported by the Reinforcement Learning Theory, which suggests that the tendency to perform an action is increased if that action is followed by a reward.[11] The reward for game-based homework in an asynchronous course can be either the intrinsic game element (achieving the goal, leveling up, etc.) or the potential academic achievement. The

willingness to perform better in the exam can be considered a 'reward' motivating students to play the games.[12]

We incorporated game-based learning as supplementary homework assignments in an online asynchronous course of the Dental Hygiene (DH) program using Gimkit. A study was conducted to evaluate the impact of game-based learning materials on student engagement and academic achievements in an asynchronous online course. Our research questions are:

1. How do students engage in game-based learning in an asynchronous online course?
2. How does game-based learning impact students' academic achievement in an asynchronous online course?

CASE DESCRIPTION

This research followed a descriptive study design, which systematically describes a population, situation, or phenomenon without identifying the underlying cause.[13,14] We aimed to illustrate student engagement and the impact of game-based homework assignments in an asynchronous online dental hygiene (DH) course. The University of Alberta Research Ethics Board (REB 2) reviewed and approved this study. The ethics approval ID is Pro00124923.

The DH program offers an oral biology course (OBIOL 202) asynchronously online to 2nd year students. In the Winter semester of 2024, 47 students were enrolled in the 2.0 credit, 15-week course to study the hard and soft tissue or oral cavity and its development. Two vodcast lectures were posted on the learning management system (LMS) each week throughout the Winter semester. Fourteen games with seven sets of practice questions were posted on the LMS as

supplementary homework assignments in alternating weeks. Each question set was posted on two different game modes to avoid possible boredom for students. The placement of the game-based homework in the course outline is shown in Figure 1.

This study involved 47 2nd year DH students who enrolled in the OBIOL 202 course in the Winter 2024 semester. Anonymized student performance data from summative exams and student engagement data from the LMS were collected. Some of the questions included in the supplementary game-based homework also appeared in the summative exams in alternative formats where the wording, format, or type of questions were changed. 52% (n=26) of the questions in the midterm exam and 42% (n=30) of the questions in the final exam were previously included in the game-based homework assignments. The difficulty indices of each question on the midterm and final exams were calculated. The difficulty index of a question refers to the percentage of the students who answered that question correctly. A higher difficulty index indicates a better overall performance of the class on that particular question.[15] The questions used in the summative exams were divided into two groups: (A) questions from concepts not reviewed by the supplementary game-based homework (B) questions from concepts reviewed by the supplementary game-based homework. The difficulty indices were compared between the two sets of questions. Statistical analyses (two-tailed t-tests) with significance defined as $p < 0.05$ were performed using Microsoft Excel.

Student engagement data, in the form of the number of interactions with the game-based homework assignments, were analyzed. Pearson's correlation coefficient between student interaction with homework and overall course grade was analyzed using Microsoft Excel. Correlation coefficients indicate the strength of a linear relationship between two variables: student

engagement and course grade. A linear correlation coefficient greater than zero indicates a positive relationship between the variables. A value less than zero indicates a negative relationship; a value of zero indicates no relationship between the variables.[16]

RESULTS

A. Student engagements with the game-based homework assignments

Ninety-four percent (n=44) of the class engaged with the supplementary homework assignments. The highest number of interactions by a single student was 48, the lowest being 3. The number of occurrences of interactions with the game-based homework assignments was plotted over the course timeline. The highest interactions were observed around weeks 8, 15, and 16 (Figure 2). Week 8 was the reading break for students, with the midterm exam on week 9. Similarly, the final exam of the course was in week 16. Week 15 was the review week before the exam, with no new lectures posted.

B. Impact of the game-based homework assignments on students' academic performances

Students' performance was evaluated in midterm and final exams. The questions of the exams were of two types: (A) questions from concepts not reviewed by the supplementary game-based homework and (B) questions from concepts reviewed by the supplementary game-based homework. The difficulty indices were compared between the two sets of questions. The average difficulty index of questions, previously reviewed by game-based homework was 92%,

significantly higher ($p = 0.0000339$) than the group of questions for which the concepts were not reviewed (Figure 3A). Similarly, for the final exam, students performed significantly ($p = 0.006$) better in questions reviewed by games (92%) compared to the questions for which the concepts were not reviewed by homework games (Figure 3B).

C. Correlation between student engagement with the game-based homework and course grade

A weak positive linear correlation (correlation coefficient, $r = 0.2$) was found between student engagement and the overall course grade (Figure 3C).

DISCUSSION

Gimkit is a relatively new platform for hosting quiz-based educational games. In this study, we describe the implementation and evaluation of game-based homework assignments created using Gimkit for an asynchronous online course. The oral biology course of the Dental Hygiene program offers a wide range of concepts on the development of teeth and surrounding oral structures. Game-based homework was introduced to the course to foster student engagement. We conducted a study to evaluate student engagement and the impact of game-based learning on their academic achievements.

Gimkit offers four game modes for homework: Fishtopia, Farmchain, Cash Tycoon, and Don't Look Down. We chose three game modes, Fishtopia, Cash Tycoon, and Don't Look Down,

to foster a unique gaming experience for the students. As Fishtopia and Farmchain have the same underlying game challenges and goals, only one from that set was chosen. Although the games were posted as supplementary activities, 44 students, 94% of the class, participated in the games. When student engagement with the game was observed throughout the timeline, a surge of interaction was observed during the reading week and the review week, right before the two summative exams of the course. High engagement with the games at that time indicates that students have played the supplementary homework game as a tool to review and reinforce their learning. This behaviour of students can be supported by the Reinforcement Learning Theory, where students were motivated by the 'reward' of potential better performance in the exam.[11,12]

When homework assignments were set, we did not put a set due date and left the games open until the last day of the course. This provided students with the flexibility to play the game at their own pace. However, setting specific due dates for homework assignments can be an effective tool to create a gated pathway with an online course, where students have to complete certain parts of the course or assignments for the next part of the course materials to be available.

Our study showed that students performed significantly better on questions based on concepts reviewed by the gameplay. This finding is aligned with previous studies showing a positive impact of review sessions on students' learning and academic performances.[17,18] Besides, quiz games like Kahoot are shown to improve students' performance and engagement in a histology course.[19]

A strong positive correlation was reported between student engagement and academic achievement.[20] Our study, however, reported a weak positive correlation between student engagement with the game-based homework assignment and the overall course grade. In a study with an online asynchronous course, Hoffman et al.,[21] showed that in addition to the frequency of engagement, regularity and immediacy are also essential for student success. In our study, the highest student interactions were observed during the reading break and before the exam. The lack of regularity in playing games may contribute to the weak positive correlation between student engagement with the games and the overall course grade.

We acknowledge some limitations of this study. The findings are based on one cohort of dental hygiene students, limiting its applicability to broader populations. No demographic data was collected. Student-specific patterns of interaction and the time spent on the games were also not evaluated. Future studies can be done with student interviews to better understand students' experiences with the game-based assignments. The engagement data collected from the LMS in our study did no report the time of engagement. Further studies are needed to analyze student engagement with game-based homework and its impact on students' academic achievement and learning experiences. Aside from these limitations, our study reveals the potential of Gimkit and game-based homework assignments as teaching and learning tools to improve students' learning experiences in online courses.

CONCLUSION

The increased popularity of online and hybrid learning in higher education necessitates the identification of new ways to engage students in online learning, especially in asynchronous courses. Quiz games from Gimkit can be a potential and powerful tool to complement traditional teaching and provide a fun way to engage students with the course materials.

Practice Implications:

- Many educators find it challenging to engage students in asynchronous online courses.
- Game-based homework, created using Gimkit, is a potentially powerful tool that provides a fun way to engage students in online asynchronous learning.

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Figures

Figure 1. The placement of game-based homework within the OBIOL 202 course timeline. The oral biology (OBIOL 202) course runs for 15 weeks and covers topics related to tooth structure and development. 14 Gimkit homework, with seven different practice question sets, was posted in the learning management system (LMS) of the course in alternating weeks.

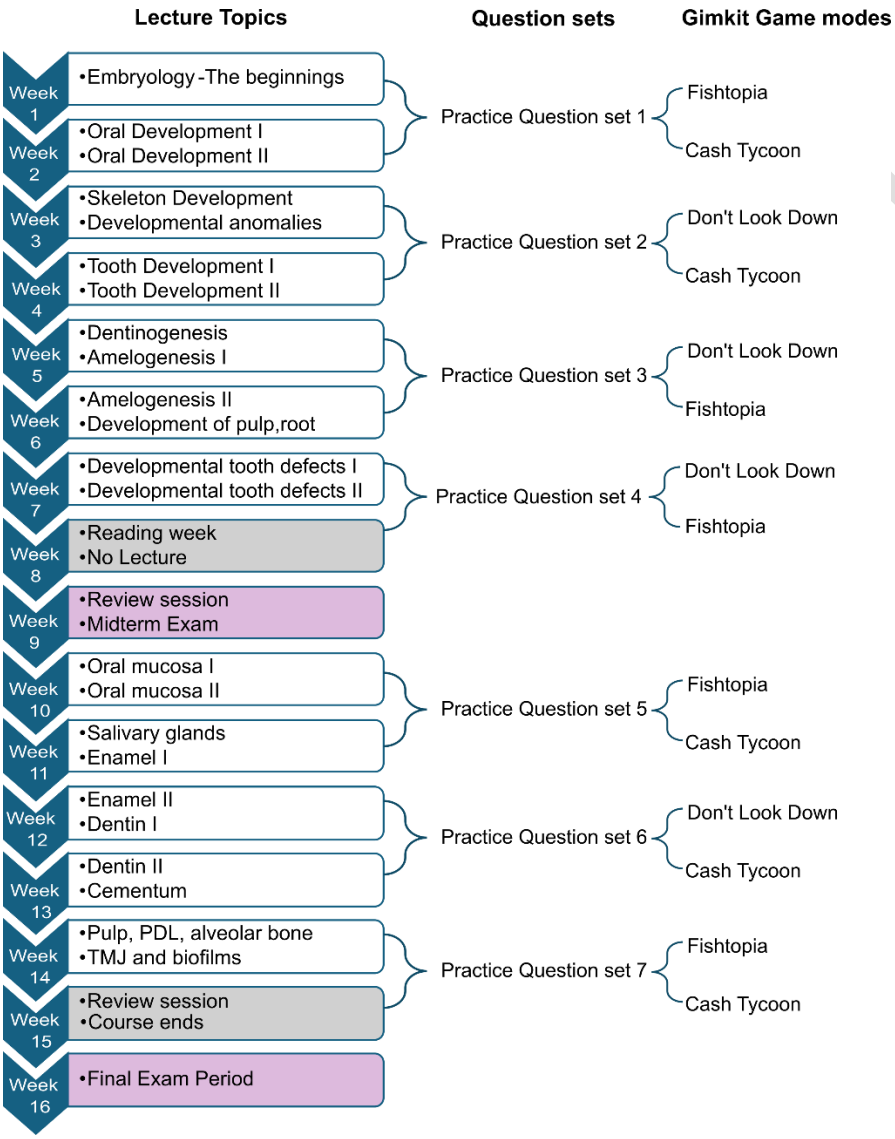


Figure 2. Student engagement with the game-based homework assignments over the course timeline. The number of occurrences of interactions with the game-based homework assignments was collected from the LMS and plotted over the course timeline.

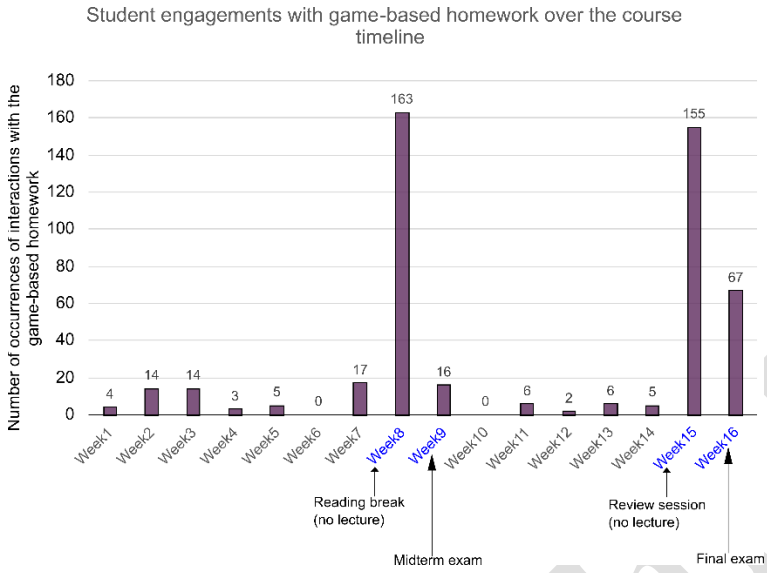
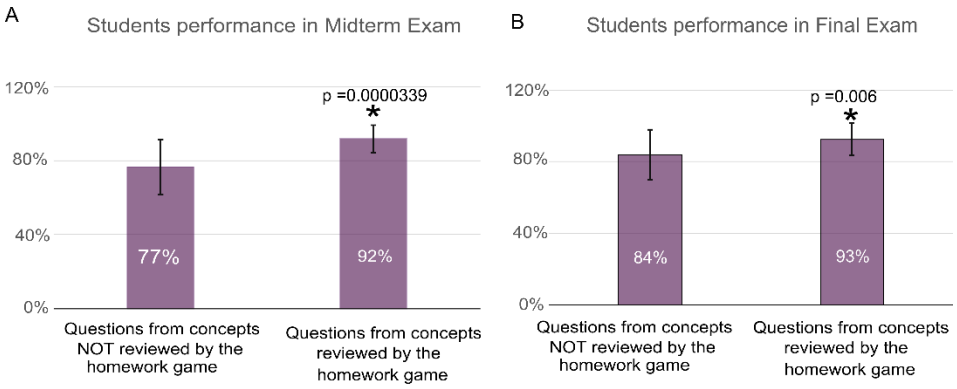
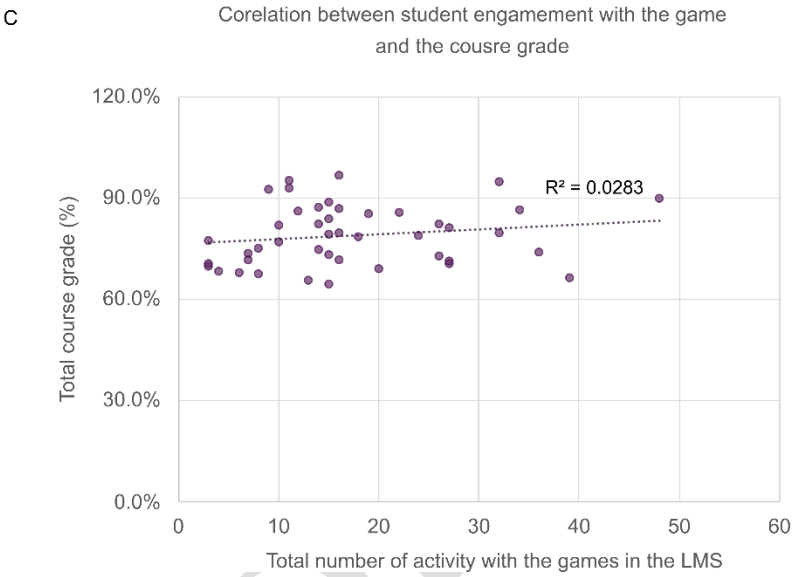


Figure 3. Students' Academic performance in the midterm (A) and final (B) exams. The questions of the exams were of two types: (i) questions from concepts not reviewed by the supplementary game-based homework and (ii) questions from concepts reviewed by the supplementary game-based homework. The difficulty indices were compared between the two sets of questions. Statistical analyses (two-tailed t-tests) with significance defined as $p < 0.05$ were performed using Microsoft Excel. (C) Pearson's correlation coefficient between student interaction with homework and overall course grade was analyzed using Microsoft Excel, which showed a weak positive linear correlation (correlation coefficient, $r = 0.2$).


A
Students performance in Midterm Exam
120%
80%
40%
0%
p =0.0000339
*
77%
92%
Questions from concepts NOT reviewed by the homework game
Questions from concepts reviewed by the homework game
B
Students performance in Final Exam
120%
80%
40%
0%
p =0.006
*
84%
93%
Questions from concepts NOT reviewed by the homework game
Questions from concepts reviewed by the homework game


C
Corelation between student engamement with the game and the cousre grade
120.0%
90.0%
60.0%
30.0%
0.0%
Total course grade (%)
R² = 0.0283
0
10
20
30
40
50
60
Total number of activity with the games in the LMS