

# Online educational games improve the learning of cardiac pharmacology in undergraduate pharmacy teaching

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## Abstract

**Background:** Educational games have been shown to be an effective learning tool in medical and nursing education.

**Aims:** To evaluate the effectiveness of online cardiac pharmacology games in engaging and motivating pharmacy students in learning pharmacology and the application of knowledge.

**Method:** Quiz questions derived from lecture notes were presented in three separate games, according to the sequence of lectures delivered in class. Each game was released to students at a specific time to complement classroom teaching. A survey was conducted to collect student feedback of the games.

**Results:** Thirty students (19.7% response rate) completed the surveys. The majority of students found the games fun, interesting, engaging, and indicated that the games had improved their understanding of concepts and principles related to the topic. More than 90% of students agreed that the game was an innovative way to understand teaching materials.

**Conclusion:** Appropriately designed online educational games engaged and motivated students.

**Keywords:** *Educational Game, Gamification, Pharmacy, Pharmacology*

## Introduction

Educational games, which can be online games and 'offline' games such as card games and board games, were introduced in the early 1990s. Serious games, a term seen more often in education, refers to computerised games that are developed for 'serious' purposes such as learning and training in educational and healthcare settings (Chatham, 2007; Burke *et al.*, 2009; Annetta, 2010). Educational games, which encourage learning by playing games, not only engage students visually and motivate them (Prensky, 2001; 2002), but also enhance knowledge acquisition and retention (Boekter *et al.*, 2013). Gamification is a commonly used term that refers to integration of gaming elements into non-game settings such as education (Johnson *et al.*, 2014), and is more widely used in medical and nursing education than in other health sciences courses (Akl *et al.*, 2010; Nevin *et al.*, 2014; McCoy *et al.*, 2016). The reported use of games in pharmacy teaching is rare (Chang *et al.*, 2015), although offline games have been used in some pharmacy schools (Barclay *et al.*, 2011; Rose, 2011; Burghardt *et al.*, 2013; Jones *et al.*, 2015). The slow adoption of games in pharmacy education may be because of uncertainty of how games could have a role in higher education, and how they can benefit both students

and educators, especially since it may be assumed that games are associated with frivolous activities (Cain & Piascik, 2015).

Blended learning has been shown to enhance teaching effectiveness and long-term knowledge (Crouch, 2009). However, an optimal mix of excellent classroom teaching and effective online learning may not occur by simply 'doing' both activities. While excellent classroom teaching comes with experience, effective e-learning requires incorporation of effective features into the learning platform, namely, suitable multimedia, interactive study, collaboration and chunking of information (Chia *et al.*, 2017). Serious games, due to the nature of their activities and effects, could easily fulfil some of these criteria, and a properly designed game may be developed as a tool for effective online learning.

The objective of this research was to address two main questions:

1. Can appropriately designed online games engage and motivate pharmacy students?
2. What features in a game are seen by students as useful and helpful?

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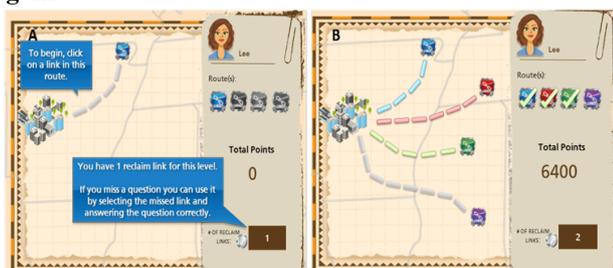
## Method

### Game design and features

Three educational games of cardiac pharmacology were developed using game templates that are available online (Articulate Global, Inc., New York, USA). As opposed to the general understanding of gamification, which applies elements associated with video games into education, such as the player (*i.e.* the student) exploring a scene, and/or engaging in dialogue with a non-player character (Boeker *et al.*, 2013), the cardiac pharmacology games developed in this study presented quiz questions in a game format. In these games, a correctly answered question was rewarded with a score and advancement in the game. Game models and online game features that are recommended for effective learning were used to develop the games. The game templates were selected if they had at least two of the following game elements: points, levels, achievements, were competitive, were interactive, were challenging, and facilitated collaborative learning (Bunchball, 2010; Schonfeld, 2010).

Quiz questions appeared in various formats, and were written based on the topics of cardiac pathophysiology and pharmacology that were taught in the Year 2 Pharmacy programme. Each game tested knowledge of specific topics, which was released to students in weeks 5, 9 and 11 of the semester, when these topics were taught in class. All the games were published as a module on the learning management system 'Moodle'. Figure 1 shows a screenshot of a representative game used in this study.

**Figure 1: A screenshot of a cardiac pharmacology game**



The player clicks on a link to answer a quiz question (A), collects points for correctly answered questions, and advances to a more challenging level of the game (B).

### Participants

An announcement was made at the end of a lecture in week 5 of semester to inform Year 2 pharmacy students about the project, and all students from both the Parkville and Malaysia campuses were enrolled in the module ( $n = 331$ ). Students were reminded to read the explanatory statement of the research, which was at the beginning of the module, before they proceeded to view the games. The explanatory statement stated that playing the games implied consent to participate in the research, that

participation was voluntary, and that students were required to submit the online surveys after they had completed the games. This research was approved by the Monash University Human Research Ethics Committee (approval number 2017-10184-13001).

### Questionnaires

Online surveys contained 11 multiple-choice items and four open-ended questions. The multiple-choice responses conformed to a five-point Likert scale format, and ranged from 'Strongly agree' to 'Strongly disagree'. Student responses to the surveys were anonymous.

### Data analysis

A semi-qualitative analysis was performed on the open-ended questions using NVivo Pro (QSR International Pty Ltd, Doncaster, Victoria, Australia). Students were asked to state what they found MOST useful (1) and LEAST useful (2) about the games, what changes could have been done to the games to improve their learning experience (3), and if they had any other comments about the games (4).

Sixty-six responses were collected for the four open-ended questions. The length of the responses ranged from a single word to two-three sentence paragraphs, resulting in a total of 1376 words. The study was exploratory in nature designed to achieve a descriptive interpretation of patterns within the data instead of simply illustrating the pre-existing theory with excerpts from the data. The analysis followed the guidelines of Braun & Clarke (2006). Step 1 (data familiarisation) involved the lead researcher reading and checking the responses. In Step 2 (initial coding), researchers A, and B examined the responses using qualitative analysis software (NVivo 11). Sentences, or small sections of text, were assigned to descriptive nodes. New nodes (compared to the initial ones identified by the lead researcher) were identified at this stage. Step 3 (searching for themes) involved the sorting of nodes into higher-level themes. Following Steps 1-3, researchers B, and A reviewed the themes to confirm that they were indeed supported by the data (Step 4, reviewing themes). During the review, themes were removed, merged, or divided. They were also renamed, where necessary, using words from educational research and those used by the respondents.

To test for inter-rater reliability, Cohen's *Kappa* coefficient was used as a statistical measure. The *Kappa* value for inter-rater reliability for the study was 0.86 (SD 0.19).

## Results

### Demographic data

One hundred and fifty two (152) out of 331 students reviewed the games but only 30 submitted the surveys (19.7% response rate). About 30% of the 152 students were from the Malaysia campus, while the rest were from the Parkville campus.

**Students' responses to the multiple-choice items in the survey**

Responses from students were largely positive (Table I). All students (100%) agreed that the objectives of the game were clearly defined, and the game instructions were easy to understand.

While most students (83%) felt that the game was appropriately challenging, more students (90%) found that the game was fun and aroused their interest. Restricted by the game design template, which does not allow more than one person participating in each game, only 30% of students agreed that they learned from their peers during the game. Interestingly, 60% of the students prefer to have this type of game compared with case study discussions. More than 90% of students agreed that the game was an innovative way to understand teaching materials. The majority of students also agreed that the game promoted discussions related to clinical practice (80%), as well as improved understanding of concepts and principles related to the topic (93%). Seventy-six percent (76%) of students perceived improvement in their critical thinking skills and problem solving skills after playing the games.

**Table I: Summary of the degree of agreement of each individual item in the questionnaires (N = 30)**

Item	Strongly agree (%)	Agree (%)	Neither agree nor disagree (%)	Disagree (%)	Strongly disagree (%)
1. The objectives of the game were clearly defined.	19 (63.3)	11 (36.7)	0	0	0
2. The instructions for the game were easy to understand.	21 (70)	9 (30)	0	0	0
3. I found the game fun and it aroused my interest.	20 (66.7)	7 (23.3)	2 (6.7)	1 (3.3)	0
4. The level of difficulty of the game was appropriately challenging.	14 (46.7)	11 (36.7)	4 (13.3)	1 (3.3)	0
5. I learned from my peers during the game.	5 (16.7)	4 (13.3)	17 (56.7)	1 (3.3)	3 (10)
6. I prefer to have the game as an alternative to case discussions.	12 (40)	6 (20)	9 (30)	1 (3.3)	2 (6.7)
7. The game was an innovative method to understand the materials.	22 (73.3)	6 (20)	2 (6.7)	0	0
8. The game promoted discussions relating to clinical practice.	8 (26.7)	16 (53.3)	3 (10)	3 (10)	0
9. The game improved my understanding of concepts and principles related to the topic.	17 (56.7)	11 (36.7)	2 (6.7)	0	0
10. The game improved my critical thinking skills.	14 (46.7)	9 (30)	4 (13.3)	3 (10)	0
11. The game improved my problem solving skills.	12 (40)	11 (36.7)	3 (10)	4 (13.3)	0

**Students' responses to the open questions**

The final nodes for question one were as follows: 1) Engaging and Fun, and 2) Improves understanding and memory. The final nodes for question three were: 1) Include more questions, and 2) Improve the nature and extend of feedback (Table II).

**Table II: The four emergent themes and representative comments for each theme**

Theme	Number of comments coded	Exemplar comments
<b>Most useful aspect</b>		
1. The games were engaging and fun	9	<i>The games made learning more fun and enhanced my understanding</i>  <i>It somehow gives us a motivation to learn more in order to pass the game.</i>  <i>I really like this interactive way of learning and wish there were more of this in the future.</i>
2. The games helped improve my understanding and memory of the content	19	<i>It enhanced my understanding of the lecture content and made me want to find out more about issues that I do not understand well enough.</i>  <i>The questions are rather specific and it stimulates my memory after reading through the notes.</i>
<b>Improvements suggested</b>		
3. I would have liked more questions	9	<i>Perhaps more questions should be added to further challenge the students</i>  <i>A larger variety of question linked directly to our lecture topics.</i>
4. Improve the nature and extent of feedback	21	<i>When it didn't give you the answers because sometimes it was hard to find the answers to the questions especially when it wasn't in our notes</i>  <i>Providing more explanation on the reason why an answer is wrong</i>

**Discussion**

In a study by Patel (2008), although students agreed that the game used in this study increased their knowledge beyond the lecture material, the game did not improve students' test scores. Half the number of the students in that study felt that the game did not help them to remember or understand test material. This suggests that educational games should not only be seen as fun, arousing interest and enjoyable, but that incorporation of elements that improve learning is necessary for achieving the learning outcomes. These elements may include activities that test knowledge, memory and understanding, and all of which should be seen as appropriately challenging by students because a balanced difficulty of tasks is able to drive students to a highly motivated state (Csikszentmihalyi, 2008). In this study, the majority of students found the games to be fun and motivating, and at the same time indicated that the games

improved their understanding of concepts and principles related to the topic, as well as knowledge retention. The data from this study clearly show that the online cardiology games successfully engaged pharmacy students, which is one essential characteristic of games that improve student performance (Gonyea & Anderson, 2009).

Competitiveness is a game element that can enhance student learning experiences, and contributes subsequently to students' better performance in assessment (Barclay *et al.*, 2011). But this element may not be very crucial since, through playing the games, students will benefit through discussion among themselves when they encounter challenges in the game (Jones *et al.*, 2015). This is consistent with this study's data where 30% of students agreed that they learned from their peers during the game. Learning will also be effective if the game is designed to close the conceptual gap that exists in lectures, which has been proven to lead to increased student examination scores (Jones *et al.*, 2015). Although we did not assess student performance in examination, it is reasonable to think that quiz questions derived from the lecture notes is also beneficial in this sense, as students noted that those types of questions helped build long-term memory and revise learning material.

Authenticity and appropriate models are required for the design of gamified learning contents, in addition to having clear and unambiguous learning objectives, rules and guidelines of gamification, because these features can increase student motivation and satisfaction (Simoes *et al.*, 2013; Urh *et al.*, 2015). The cardiology games have been successful in these regards because most of the students acknowledged the games as an innovative way to understand teaching materials, and all students agreed that the objectives of the game were clearly defined and the instructions of the games were easy to understand.

It is interesting that a majority of students in this study preferred the online games over case study discussions, although the latter is one of the most liked features of an effective online learning module (Lee & Sen, 2018). Accordingly, the scores and reward that accompanied a correct answer in a game are most likely the triggers that have motivated students to continuously explore knowledge and learning, as it has been reported previously that the essence behind success in gamification is the reward system (Kapp, 2012).

The advantage of gamification is its capacity to increase student motivation, even for contents that most students do not like to learn (Boeker *et al.*, 2013). Students who find game-based e-learning motivating and fun might have spent more time in learning, and consequently achieved better cognitive results (Boeker *et al.*, 2013). The data from this study support this finding where it is likely that students' improved perceived self-efficacy and motivation lead to deep learning (Prat-Sala & Redford, 2010), which contributed to promotion of discussions related to clinical practice, even though the game content is largely pharmacology-based. The four elements that good games have in common are goals, rules, feedback,

and voluntary participation (McGonigal, 2011). The games designed by the authors fulfilled all these criteria, but one area that could be improved upon is the nature and extent of feedback. A large amount of feedback to players is indicated as one of the criteria of a well-designed educational game (Garris, *et al.*, 2002). Other aspects suggested are continuous opportunities for player improvement, tasks too complex to be solved alone, and environments that change in response to learners' actions (Garris, *et al.*, 2002; Barab *et al.*, 2010).

In summary, this study shows that an appropriately designed educational game can effectively engage pharmacy students, and it can be developed as an online module to complement classroom teaching in the blended learning approach. The educational game needs to strike a balance between educational contents and gaming elements, and student feedback indicated that a video game-like format was not required in order to effectively engage students. It is possible to develop educational games, without dedicated funding and advanced technological skills. Key game features seen as useful and helpful by pharmacy students include whether or not the games are interactive and challenging, have clear objectives, as well as simple rules and guidelines, and provide adequate feedback.

### Study limitations

This study was limited by the small sample size, which was contributed in part by the ethical way the research was conducted. Participation in this research project was voluntary, rather than compulsory. Non-participation or non-completion of the module has no impact on students' final grades in the unit. Moreover, the time that students spent in reviewing the module was not included in their total learning hours of the unit.

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### Conflicts of interest

There was no conflict of interest.

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