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REVIEW

Game-based learning in pharmacy education: A systematic review and narrative synthesis

Seham Kanaan[1], Mariam Dabbous[1], Marwan Akel[1,2,3,4], Rebecca Lteif[1], Mohamad Rahal[1], Fouad Sakr[1,3,5,6]

[1] School of Pharmacy, Lebanese International University, Beirut, Lebanon
[2] School of Education, Lebanese International University, Beirut, Lebanon
[3] INSPECT-LB: Institut National de Santé Publique, d'Épidémiologie Clinique et de Toxicologie-Liban, Beirut, Lebanon
[4] International Pharmaceutical Federation (FIP), The Hague, The Netherlands
[5] UMR U955 INSERM, Institut Mondor de Recherche Biomédicale, Université Paris-Est Créteil, France
[6] École Doctorale Sciences de la Vie et de la Santé, Université Paris-Est Créteil, France

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Correspondence
Fouad Sakr
School of Pharmacy
Lebanese International University
Mussaitbeh
Salim Salam
Beirut
Lebanon
fouad.sakr@liu.edu.lb

Abstract

Background: Studies have shown improved learning outcomes using game-based learning (GBL) in health professions education. The aim of this systematic review was to explore and summarise the current evidence related to the design, assessment methods, and outcomes of implementing GBL in pharmacy education. It also aimed to determine and the impact of gamified learning activities on students' perception and attainment of the desired learning outcomes. **Methods:** A comprehensive search was undertaken using the PubMed, Scopus, and Google Scholar databases. The Preferred Reporting Items for Systematic Reviews and Meta-Analysis (PRISMA) guideline was used for reporting this systematic review. **Results:** A total of 22 studies involving pharmacy students were included. GBL was utilised for a variety of pharmacy-related topics or courses including major and elective didactic courses and pharmacy practice experiences. Evaluation of GBL activities was mostly based on post-game surveys or/and quizzes. All studies showed a positive impact of game-based learning on pharmacy education. **Conclusion:** GBL has an important role in pharmacy education in both didactic and practicum courses. Findings show that the benefits of GBL are prominent through different areas of the pharmacy curriculum and in all professional pharmacy years.

Introduction

Educators with diverse backgrounds and expertise aim to foster student engagement and motivation within their respective educational settings (Akel *et al*., 2020). Teaching in general has become challenging due to increasingly apathetic students, creating the need for more interactive teaching methods (Wood & Reiners, 2012). Integrating emerging technologies within the education sector, such as game-based learning, has demonstrated a beneficial effect on students' engagement, skill development, and the practical application of these skills (Almeida & Simoes, 2019).

Gamification can be defined as "*using game-based mechanics, aesthetics and game thinking to engage people, motivate action, promote learning, and solve problems*" (Rice, 2012). Learning outcomes from educational games can be classified into three categories including skill-based, cognitive learning, and affective knowledge (Ben-Zvi & Carton, 2007). Common game design elements that have been used to gamify education include points, levels/stages, badges, leaderboards, prizes and rewards, progress bars, storylines, and feedback. These game designs yield numerous favourable effects on the learner's outcomes, primarily enhancing engagement, involvement, motivation, enjoyment, and overall performance (Nah *et al*., 2014).

Gamification is used as a tool in clinical education for undergraduate and graduate medical students, nursing students, and pharmacy students. One of the key advantages of game-based learning in clinical education is that it can allow real-world application and risk-free healthcare decisions. Studies have shown that game-based learning confers advantages when incorporated as an educational instrument in medical, pharmacy, and nursing schools (Krishnamurthy *et al*., 2022). Although various studies have shown improved learning outcomes using gamification in health professions education, there is still a need for more rigorous and higher-quality research (Gentry *et al*., 2019; van Gaalen *et al*., 2021; Hope *et al*., 2022).

The Accreditation Council for Pharmacy Education (ACPE) requires the utilisation of active learning in pharmacy education as one of its accreditation standards (Sakr *et al*., 2022). Active learning is an instructional approach that engages students in activities and participation, encouraging them to actively process and apply knowledge rather than passively receiving information (Stewart *et al*., 2011). Gamification is considered as one of the active learning approaches as it engages students and motivates them to attain outlined learning outcomes or skills and provides them with feedback on their performance (Bai *et al*., 2020). A neuroscience study has shown that gamification can deactivate the default mode network, a brain region which is usually active when at rest or not engaged in a cognitive activity (Howard-Jones *et al*., 2015).

Many studies in the literature have revealed the positive effect of game-based learning in pharmacy education and on students' performance and engagement. In fact, game-based learning or gamification has been incorporated into many pharmacy-related topics or courses in the pharmacy education field using variable game designs and levels of technology. However, the assessment of learning outcomes in game-based learning is limited and not well-defined (Oestreich & Guy, 2022). Moreover, there is a need to publish further research related to improved skills, knowledge, and grades after implementing game-based learning in pharmacy education to further advocate the use of gamification in the pharmacy classroom (Sera & Wheeler, 2017).

The aim of this systematic review was to explore and summarise the current evidence related to the design, assessment methods, and outcomes of implementing game-based learning in pharmacy education. It also aimed to determine the impact of gamified learning activities on students' perception and attainment of the desired learning outcomes.

Methods

The protocol for this review was reviewed and registered by the ethics and research committee of the School of Pharmacy at the Lebanese International University and was assigned 2020RC-064-LIUSOP as a registration number.

Search strategy

The Preferred Reporting Items for Systematic Reviews and Meta-Analysis (PRISMA) guideline was used for reporting this systematic review (Page *et al*., 2021). A comprehensive search was undertaken using the PubMed, Scopus, and Google Scholar databases from their establishment until June 2022. Employed terms were: game-based learning, gamification, gamified, learning, education, pharmacy, pharmacy education, pharmacy practice, pharmaceutical sciences, clinical pharmacy, and learning outcomes. Moreover, experts in the area were contacted, reference lists of all relevant publications were examined, and citations of included works were tracked down. There were no constraints on the publishing language or study design.

Selection criteria

Inclusion criteria

All study designs describing/examining game-based learning in pharmacy education were considered for inclusion.

Exclusion criteria

Studies were excluded if they included other health professions (i.e. interprofessional education) or game-based learning activities for non-pharmacy disciplines.

Study selection process

All identified publications were assessed independently by two reviewers, with any disagreements resolved by discussion or handled by a third independent reviewer. Retrieved records were imported to a shared Google Drive, and duplicates were removed. The remaining studies' titles and abstracts were evaluated against the inclusion and exclusion criteria in the first stage, and irrelevant studies were eliminated. In the second stage, full texts of all potentially relevant studies were retrieved and assessed against the inclusion and exclusion criteria or when a decision could not be reached based on the titles and abstracts. The PRISMA flow diagram provides the reasons for research exclusions at the full-text review stage (Figure 1).

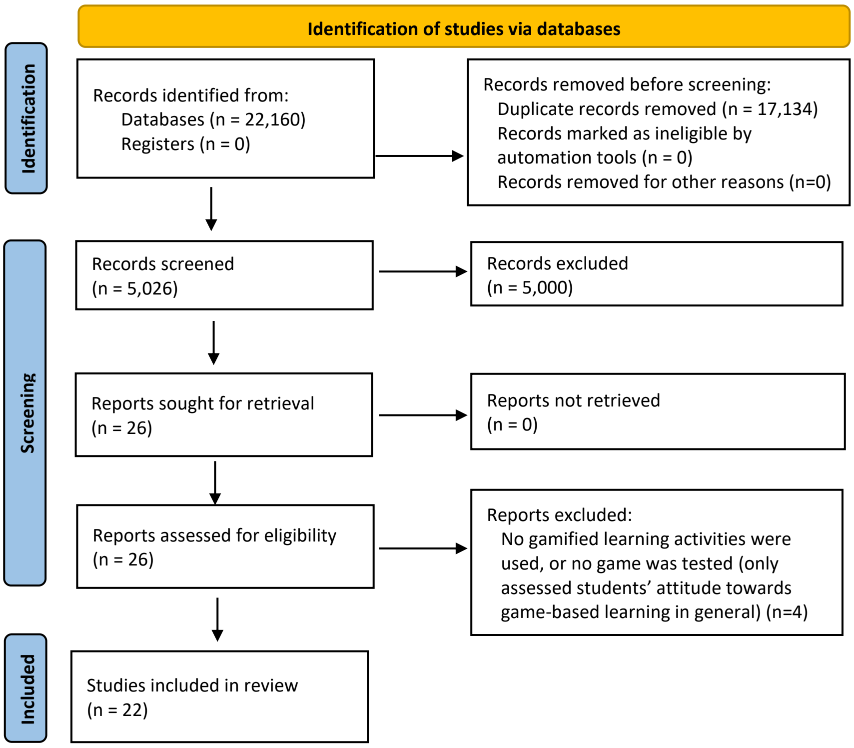

Figure 1: The PRISMA flow diagram of studies in the review

Data extraction

Data on the following items were extracted from each included study: design, setting, source of data, study population, sample size, game design and name, assessment tools, and outcome measures of game-based learning in pharmacy education. In all included studies, all necessary data were provided. As a result, no authors were contacted. Two reviewers independently extracted data from included papers, and differences were resolved through discussion or the engagement of a third reviewer. The present review authors who co-authored papers included in this review were not involved in data extraction to eliminate any potential reviewer bias.

Data analysis

The conduction of a meta-analysis was not possible because of the heterogeneity of measurements between the studies. Therefore, a narrative synthesis was employed.

Results

Study selection

The systematic review search identified 22,160 records. Thereafter, 17,135 duplicates were removed, and 5,000 were excluded based on the screening of titles and abstracts. Afterwards, 26 reports were retrieved and evaluated. After the full-text evaluation, four studies didn't meet the inclusion criteria and were excluded. A total of 22 studies were included in this systematic review. Figure 1 shows the PRISMA flow diagram of the literature search and study selection process.

Study characteristics

All of the included studies were in English language. Studies were mainly conducted by schools of pharmacy of different universities in different countries including United States, United Kingdom, Australia, Lebanon, and others. Few studies were conducted by other schools in collaboration with schools of pharmacy, as the primary aim was designing a prototype game for pharmacy education that was then tested by pharmacy students (Hookham *et al.*, 2015; Lambertsen *et al.*, 2016; Kamnardsiri *et al.*, 2017; Nabhani *et al.*, 2020). These schools included College of Arts, Media, and Technology (Kamnardsiri *et al.*, 2017), School of Design, Communication, and IT (Hookham *et al.*, 2015), Department of Computer Science (Lambertsen *et al.*, 2016), and School of Computer Science and Mathematics (Nabhani *et al*., 2020). In all studies, participants were pharmacy students.

Table I presents some of the characteristics of the included studies relating to the pharmacy topic/course in which an educational game was applied, sample size, and participants' academic year (pharmacy year). In the included studies, game-based learning was utilised for a variety of pharmacy-related topics or courses. Most educational-based games were implemented as part of specific courses in the pharmacy curriculum. These courses widely ranged between major didactic courses such as pharmacology (Shah *et al*., 2010; Lee *et al*., 2018), therapeutics (Patel, 2008; Duffull & Peterson, 2020), and biochemistry (Rose, 2011), elective courses such as geriatrics (Kennedy *et al*., 2004), professional communications (Evans *et al*., 2005), and experiential education courses such as advanced pharmacy practice experiences (APPEs) (Barclay *et al*., 2011).

Table I: Characteristics of the included studies

Study	Course/topic	Sample size	Pharmacy year
Lee *et al*. 2018 (Lee *et al*., 2018)	Cardiac pharmacology	30	PY2
Barclay *et al*. 2011 (Barclay *et al*., 2011)	APPE (ID/Cardiology pharmacotherapeutics)	45	(APPE = PY4)
Duffull *et al*. 2020 (Duffull & Peterson, 2020)	Therapeutics	120 Y2 + 115 Y4	PY2 + PY4
Kamnardsiri *et al*. 2017 (Kamnardsiri *et al*., 2017)	Medical history-taking skills, diagnosis, drug-dispensing, national pharmacy exam questions	12	
Whitman *et al*. 2019 (Whitman *et al*., 2019)	Brand/Generic drug memorisation as part of "*Professional development*" course	68 (class 2020) + 70 (class 2019 control)	PY1
Hookham *et al*. 2015 (Hookham *et al*., 2015)	Dispensing	10	-
Lambertsen *et al*. 2016 (Lambertsen *et al*., 2016)	Pharmacist communication and drug administration	6	Level 6 M.Pharm. (3rd year)
Lam *et al*. 2019 (Lam *et al*., 2019)	Healthcare communication/ Psychiatry and neurology	79	PY1
Bangalee *et al*. 2021 (Bangalee *et al*., 2021)	Pharmacy practice/Pharmacology	10	Third year
Dabbous *et al*. 2022 (Dabbous *et al*., 2022)	Pharmacy practice experience	69 + 164 control	Fourth year
Kennedy *et al*. 2004 (Kennedy *et al*., 2004)	Geriatric electives	47	PY1, PY2, PY3, PY4
Nabhani *et al*. 2020 (Nabhani *et al*., 2020)	Drug information (BNF)	152	Level 6 and 7 M.Pharm. (3rd and 4th year)
Patel 2008 (Patel, 2008)	Principles of human disorders pharmacotherapeutics clinical case studies I and II	128	PY3
Evans *et al*. 2005 (Evans *et al*., 2005)	Professional communications	102	PY1
Chen *et al*. 2011 (Chen *et al*., 2011)	Pharmacy practice skills lab	625	PY1
Roche *et al*. 2004 (Roche *et al*., 2004)	Early pharmacy practice experience	-	PY3
Grady *et al*. 2013 (Grady *et al*., 2013)	Advanced psychiatric elective	160	PY3
Shah *et al*. 2010 (Shah *et al*., 2010)	Pharmacology/Medicinal chemistry (Gastrointestinal)	82 (2008) + 90 (2009)	-
Rose 2011 (Rose, 2011)	Biochemistry (Metabolism of carbohydrates, lipids, and amino acids)	92	PY1
Sando *et al*. 2013 (Sando *et al*., 2013)	Medication history interviews in preparation for IPPE at ambulatory clinic sites	200	PY2
Tietze 2007 (Tietze, 2007)	Introduction to clinical pharmacy skills	130 (Autumn) + 116 (Spring)	PY1
Persky *et al*. 2007 (Persky *et al*., 2007)	Foundations in pharmacokinetics course and applied pharmacokinetics course	132	PY2

APPE = Advanced Pharmacy Practice Experience; ID = Infectious Disease; PY1 = First professional year; PY2 = Second professional year; PY3 = Third professional year; PY4 = Fourth professional year; M.Pharm. = Master's Degree in Pharmacy; - = Not stated; BNF = British National Formulary.

Few studies in this review were general design and application of a game for pharmacy students that targeted certain pharmacy related topics or skills, without applying the game in a specific course (Hookham *et al*., 2015; Lambertsen *et al*., 2016; Kamnardsiri *et al*., 2017; Nabhani *et al*., 2020). Sample size varied widely depending on the aim of the study, type of course involved, number of volunteering students, and whether it is a pilot study. Participants involved in the studies were mostly in their professional pharmacy years (third year and above). This is mostly to apply gamified learning to more advanced courses, topics, or skills rather than basic sciences courses.

Game design/name and assessment

Table II summarises game design, name, and the assessment tools for the gamified learning activities. Game designs varied between studies with high variability in technology used ranging from board games and basic online games to advanced software simulation games. Evaluation of game-based learning activities was mostly based on post-game questionnaires or surveys. Questionnaires were either quizzes to assess knowledge or questions to assess perception and benefit post-game, or both. Some studies had pre-test and post-test to compare exam or quiz scores (Barclay *et al*., 2011; Rose, 2011; Nabhani *et al*., 2020;), and others compared test results with previous years or control group in which game-based learning was not implemented (Persky *et al*., 2007; Tietze, 2007; Whitman *et al*., 2019; Dabbous *et al*., 2022). One study also measured participation grade and compared it to previous years to reflect students' engagement (Patel, 2008). Only one study included preceptors to fill assessment rubrics to assess students' post-game performance. Although no pre-game rubrics were filled to compare results, preceptors reported positive improvement in performance compared to pre-game performance (Sando *et al*., 2013). Moreover, one study assessed the impact of game-based learning on attaining intended learning outcomes, where the course learning outcomes were evaluated using exam total average and subsequent averages of four predefined competency-based domains (Dabbous *et al*., 2022).

Table II: Game design/name and assessment tools for gamified learning activities

Study	Game design/name	Assessment tools
Lee *et al*. 2018 (Lee *et al*., 2018)	Quiz questions in a game format using online game templates	Post-game questionnaire
Barclay *et al*. 2011 (Barclay *et al*., 2011)	Educational card games "*Cardiology Go Fish and Infectious Diseases Gin Rumm*y"	Pre- and post-assessment questions/ VARK questionnaire
Duffull *et al*. 2020 (Duffull & Peterson, 2020)	Patient simulation using software platform "*SimPHARM*"	Post-game questionnaire
Kamnardsiri *et al*. 2017 (Kamnardsiri *et al*., 2017)	"*Game Based Learning System*" developed by a cross-platform game engine (unity Game engine) (prototype game)	Post-game questionnaire
Whitman *et al*. 2019 (Whitman *et al*., 2019)	An electronic flashcard/ quiz/ gaming platform "*Quizlet*"	Quiz results were compared to results from the previous year. Survey to assess students' perception
Hookham *et al*. 2015 (Hookham *et al*., 2015)	Software game that created 3D simulation of community pharmacy "*Virtual Dispensary*" (prototype game)	Post-game questionnaire
Lambertsen *et al*. 2016 (Lambertsen *et al*., 2016)	Virtual Patient Simulator (Serious Game using Adobe Flash) "*PharmaComm*" (prototype game)	Focus group was run after the experiment to obtain feedback on the participants' experience
Lam *et al*. 2019 (Lam *et al*., 2019)	Software simulation including player avatars "*Mimycx quest games*"	Pre- and post-questionnaires
Bangalee *et al*. 2021 (Bangalee *et al*., 2021)	Board Game "*PharmacyPhlash*"	Post-game questionnaire
Dabbous *et al*. 2022 (Dabbous *et al*., 2022)	Different gaming platforms "*Gamilab*", "*Wisc-Online*", and "*Quizizz*" Students divided into teams to answer case scenarios and earn points	Attainment of intended learning outcomes (exam grades) ALMAS score to assess motivation
Kennedy *et al*. 2004 (Kennedy *et al*., 2004)	Board game (simulation game format in a traditional classroom setting) "*The Age Game*"	Post-game survey
Nabhani *et al*. 2020 (Nabhani *et al*., 2020)	Web-based quiz to assess retrieval ability in a national formulary "*Pharmacy Challenge*" (prototype game)	Pre- and post-game quiz Post-quiz questionnaire.
Patel 2008 (Patel, 2008)	Games based on television quiz show and classic board game format "*Trivia Pursuit*", "*Jeopardy*", "*Cranium*", "*Monopoly*", "*Battle of the Sexes*", "*Hollywood Squares*", and "*Operation*"	Post-game questionnaire. Participation grades were compared to previous year
Evans *et al*. 2005 (Evans *et al*., 2005)	Structured role-playing game "*Geriatric Medication Game*"	Pre-game and post-game questionnaire

Table II: Game design/name and assessment tools for gamified learning activities (Continued)

Study	Game design/name	Assessment tools
Chen *et al*. 2011 (Chen *et al*., 2011)	Structured role-playing game "*Geriatric Medication Game*"	Post-game questionnaire (reflection questions)
Roche *et al*. 2004 (Roche *et al*., 2004)	Team-based game to answer MCQs and open-ended questions "*Who Wants to Be a Med Chem Millionaire*?"	Post-game survey
Grady *et al*. 2013 (Grady *et al*., 2013)	3 games utilised in a large classroom setting "*Who Wants to Be a Millionaire*", "*Jeopardy*", and "*Survivor*"	Survey instrument
Shah *et al*. 2010 (Shah *et al*., 2010)	Crossword puzzle created using free internet resource	Survey instrument
Rose 2011 (Rose, 2011)	Board game "*Race to glucose*"	Survey instrument. Pretest-Posttest
Sando *et al*. 2013 (Sando *et al*., 2013)	Board (role play) game "*Medication Mysteries Infinite Case Tool (MMICT)*"	Individual performance assessment rubrics filled by preceptors post-game only Pre- and post-game survey instrument filled by students
Tietze 2007 (Tietze, 2007)	Bingo game with different learning activities (e.g. video, crossword puzzle, quiz)	Grades (Bingo = bonus) Post-game survey
Persky *et al*. 2007 (Persky *et al*., 2007)	3 team-based classroom games "*Pk Poker*", "*Pharmacy scene investigation*", "*Clue Game*"	Post-game questionnaire Final examination scores (compared to previous year)

VARK = Visual, Aural, Read/write, Kinesthetic questionnaire; ALMAS = Active Learning Motivation Assessment Scale

Game-based learning outcomes

Although studies had variable objectives and endpoints to measure, all studies showed a positive impact of game-based learning on pharmacy education. Studies reported positive attitudes, better understanding of topics, increased confidence, and better engagement of students after incorporation of the game-based learning activities. Examination or quizzes scores as well as participation grades were also higher after implementation of the gamified activities. Table III summarises the main outcomes and the summary of each study results.

Table III: Main outcomes and summary of each study results

Study	Main outcomes and summary of results
Lee *et al*. 2018 (Lee *et al*., 2018)	Students reported improved understanding and found the game engaging and innovative.
Barclay *et al*. 2011 (Barclay *et al*., 2011)	Assessment scores improved significantly ($p < 0.001$). Student learned regardless of their learning preference (as determined by VARK).
Duffull *et al*. 2020 (Duffull & Peterson, 2020)	Thematic analysis identified improvements of feeling in control and ability to make decisions.
Kamnardsiri *et al*. 2017 (Kamnardsiri *et al*., 2017)	75% of students reported a high overall satisfaction.
Whitman *et al*. 2019 (Whitman *et al*., 2019)	Significant higher scores were reported (average 94.1% *vs*. 86.9% $p < 0.01$). Positive perception and enjoyment.
Hookham *et al*. 2015 (Hookham *et al*., 2015)	Students considered it a good way to learn dispensing practices and increase confidence.
Lambertsen *et al*. 2016 (Lambertsen *et al*., 2016)	Participants considered it engaging and a stress-free way to learn and practice.
Lam *et al*. 2019 (Lam *et al*., 2019)	Increased familiarity with virtual educational gaming. Students found the software "*was a worthwhile learning experience*".
Bangalee *et al*. 2021 (Bangalee *et al*., 2021)	Students reported high level of satisfaction and a fun way to learn.
Dabbous *et al*. 2022 (Dabbous *et al*., 2022)	Higher exam average and higher motivation among game-based learners compared to the control group ($p < 0.001$). Validation of the ALMAS for game-based learning. Game based learners with higher motivation scores had higher exam grades ($p = 0.004$).
Kennedy *et al*. 2004 (Kennedy *et al*., 2004)	Students reported enhanced problem-solving skills and critical thinking, actively involved students in the learning process, prepared students to counsel geriatric patients, and helped prepare students to become competent pharmacists.
Nabhani *et al*. 2020 (Nabhani *et al*., 2020)	93% of students felt the game helped them in their academic skills. 55% of students had improved confidence. Significant improvement in quiz scores ($p < 0.05$).

Table III: Main outcomes and summary of each study results (Continued)

Study	Main outcomes and summary of results
Patel 2008 (Patel, 2008)	Students reported that game approach was beneficial in their learning process. Games increased interest, participation, and participation grades ($p < 0.001$).
Evans *et al*. 2005 (Evans *et al*., 2005)	Significant post-game change in perceptions and attitudes towards elderly (increased empathy and understanding).
Chen *et al*. 2011 (Chen *et al*., 2011)	Themes identified from students' reflection: Improved attitude towards elderly, better understanding of elderly experiences, and increased willingness to help elderly.
Roche *et al*. 2004 (Roche *et al*., 2004)	Students valued the game as positive learning experience.
Grady *et al*. 2013 (Grady *et al*., 2013)	Students agreed that games were effective to promote learning.
Shah *et al*. 2010 (Shah *et al*., 2010)	Students reported enhanced learning experience.
Rose 2011 (Rose, 2011)	Students considered the game enjoyable and helpful. Higher post-test exam scores (compared to pre-test).
Sando *et al*. 2013 (Sando *et al*., 2013)	58% and 39% of students achieved excellence or competence, respectively, on the assessment. Significant Improvement in students' self-efficacy and confidence ($p < 0.001$).
Tietze 2007 (Tietze, 2007)	Students who achieved Bingo had higher grades (compared to previous terms). Students valued positively the game. Game increased student interaction and provided opportunity to demonstrate active learning.
Persky *et al*. 2007 (Persky *et al*., 2007)	Students had positive attitude towards game incorporation in classroom. 2 Games had a positive impact on grades ($p < 0.001$).

VARK = Visual, Aural, Read/write, Kinesthetic questionnaire; ALMAS = Active Learning Motivation Assessment Scale

Discussion

Game-based learning activities are designed to immerse students in interactive learning environment (Aburahma & Mohamed, 2015). A total of 22 studies were included in this systematic review. Students involved in the studies were mostly in their third-year pharmacy and above. The studies were conducted in different countries such as the United States, United Kingdom, Australia, Lebanon, and others allowing for the extrapolation of the results obtained. Overall, the 22 articles showed the positive impact of game-based learning on pharmacy education. Gamified learning activities were applied in different pharmacy courses and topics including didactic courses and experiential education. The study by Dabbous and colleagues (2022) was performed in experiential education during a pharmacy practice experience course, whilst other studies applied game-based learning on didactic courses. This allowed to interpret the effectiveness and outcomes of gamification on different competencies, and its applicability on different areas of the pharmacy curriculum.

Gamified activities can vary greatly in features such as the amount of technology used in the exercise. In the analyzed studies, different game designs were used with primary outcomes around the effectiveness of game-based learning regarding performance, attaining the intended learning outcomes, motivation, and perception. Some studies used software platforms such as simPHARM, Mimycx quest game, and other platforms with a post-game questionnaire (Hookham *et al*., 2015; Kamnardsiri *et al*., 2017; Duffull & Peterson, 2020), with one study also used a pre-game questionnaire assessment (Lam *et al*., 2019). When using these platforms especially in the simulation courses, students showed control and ability to make decisions, and increased confidence and familiarity with educational gaming. Some studies also incorporated board games as platforms for game-based learning (Kennedy *et al*., 2004; Rose, 2011; Sando *et al*., 2013; Bangalee *et al*., 2021), with a post-game questionnaire filled by students for assessment. Only one study incorporated a post-game assessment rubric that is filled by preceptors (Sando *et al*., 2013). Board games showed their effectiveness in increasing exam scores and enhancing problem-solving and critical thinking.

Students were highly motivated to participate in gamified learning activities and this was significantly correlated with achieving better learning outcomes (Dabbous *et al*., 2022). In addition, online games, quizzes, and puzzles supported team-based learning, enhanced participation, and increased interest in the learning activities. Game-based learning appeared to be useful and efficient to engage students in the learning process, and improve their self-confidence and examination scores. This hypothesis was verified by using an escape room on a sample of Pharm.D. (Doctor of Pharmacy) students to teach them clinical concepts in toxicology (Korenoski *et al.*, 2021). Findings showed a substantial improvement in exam scores after the gamified learning. Students also reported that the activity improved their knowledge about toxicology and enhanced their confidence to manage similar cases. Most of the sample were satisfied with the experience and recommended it for inclusion in other courses in the programme.

Promising findings were also reported from other study disciplines. A recent study by Chen and Tang in 2022 designed a digital game to integrate a role-play with cognitive scaffolding to help university students in Taiwan improve their digital literacy and technology skills. Findings revealed that game-based learners had a significant improvement in learning effectiveness compared to traditional learners. Moreover, game-based learners were highly engaged in the learning activity and reflected a higher acceptance for learning technology. A systematic review by Byusa and colleagues (2022) assessed the impact of game-based learning on motivating students and enhancing their understanding of chemistry concepts. A total of 57 studies were reviewed on chemistry gamified learning from 2010 to 2021. The main outcomes showed enhanced conceptual understanding of concepts and increased motivation to learn while having fun. The review also identified a positive role of gamification in practical labs of chemistry, which is consistent with the findings of the current review that showed a positive role for gamifications in pharmacy practice experiences in addition to didactic courses.

Practical implications

The professional pharmacy curriculum is expected to equip students with the necessary knowledge, competence, and professional behavior to provide patient care in the clinical settings, and to support the community with high standard services. This mandates a dynamic curriculum to rival with the continuous health and societal challenges, and entails a continuous evaluation of the current courses and teaching methodologies (Safwan *et al.*, 2022). This review indicates that game-based learning has an important role in pharmacy education in both didactic and practicum courses. Findings show that the benefits of gamified learning activities are prominent through different areas of the pharmacy curriculum and in all professional pharmacy years. Educational games can provide pharmacy educators and preceptors with an important pedagogical tool for theoretical and experiential learning. The gamified activities appear highly motivational for students, with favorable results on the learning process and outcomes. Therefore, game-based learning is recommended for further utilisation and research in pharmacy education. On the other hand, cultural and contextual factors can influence game-based learning by affecting language, cultural relevance, educational practices, technology access, and socioeconomic disparities, which collectively impact how well learners engage with and benefit from game-based educational tools. Further research is recommended in this context in order to determine the impact of these confounding factors on the game-based learning outcomes.

Strengths and limitations

This study employed a thorough search technique that included pertinent bibliographic databases. The included studies had samples from different professional years of pharmacy and took place in both didactic and practical courses. Furthermore, the reviewed studies tackled different pharmacy areas and concepts, as well, they captured the impact of gamification on the learning outcomes and students' perception and motivation. The studies were also from several different countries, which could provide some generalisability to the findings. On the other hand, one limitation of this review is that it was unable to statistically synthesise the data with a meta-analysis because of methodological heterogeneity between the studies. The methodological approach also varied between the included studies. Most of the studies didn't include a control group to compare game-based learning to traditional learning in the same course or context. In addition, nearly half of the studies included assessment in the post-game setting only, and thus didn't reveal comparative data between pre- and post-gamified activities. Besides, none of the studies assessed the technological and financial challenges that could be associated with the implementation of game-based learning. These challenges could include cost development, access to technology, content maintenance, training and support, and infrastructure and resources. Educators should consider these challenges when incorporating gamified activities into their educational settings. Additional research is suggested in this context to identify all challenges that may arise from utilising gamified learning. Finally, although rigorous efforts were taken to warrant that this systematic review included all papers on game-based learning in the pharmacy education to date, some studies may have been missed.

Conclusion

The present review revealed that game-based learning has a positive role in pharmacy education. This role is not limited to didactic courses but also it extends to pharmacy practice experiences. Students appear to have positive attitudes towards gamified learning, and highly motivated to engage on these activities. Game-based learning is evidently associated with improved learning effectiveness and outcomes in pharmacy education. Further research is recommended to explore technical and financial challenges of using gamified learning activities in a pharmacy curriculum.

Conflict of interest

The authors declare no conflict of interest.

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