



Review

The use and impact of game-based learning on the learning experience and knowledge retention of nursing undergraduate students: A systematic literature review

Nuno Tavares^{*}

University of Portsmouth, United Kingdom of Great Britain and Northern Ireland



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ABSTRACT

Background: Active engagement of nursing students has deteriorated overtime, especially during the global pandemic. Therefore, there has been a widespread search for learning methods that incorporate digital technologies and active student participation in recent years. Game-based learning may be an option, as it uses game-design elements to enhance academic performance and learning. Its use in nursing education is, however, limited.

Objectives: The literature review aimed to explore student experience and learning when using game-based learning and to understand its uses in the nursing curriculum.

Design: Systematic literature review using the *Preferred Reporting Items for Systematic Reviews and Meta-analysis*.

Data sources: ESBCO Discovery Service was used to search healthcare, science and education-related databases.

Review methods: A comprehensive search of English language primary research published between 2017 and 2022 on the use of game-based learning in nursing undergraduate education was conducted. Data was analysed using thematic analysis.

Results: Seventeen papers from 4 different countries were included. The studies explored interventions and subjects of increased teaching complexity that required increased levels of knowledge retention and critical thinking, such as nursing theory and complex clinical skills. Three themes emerged from the literature, including: approaches to game-based learning; student experience and engagement; impact of game-based learning on student learning and knowledge retention. Studies used a wide range of learning methods, such as quizzes, escape rooms and serious games. These methods were in general well-accepted by students, who endorsed its widespread use in the nursing curriculum. Most studies reported an increase in student experience and learning when using game-based learning, although time-limited games can often increase anxiety on students.

Conclusions: Game-based learning is an important alternative to traditional teaching methods. However, the recurrent use of game elements and its limited long-term effects may pose a limitation to its widespread use in nursing undergraduate education.

1. Introduction

Nursing education aims to integrate theoretical and practical knowledge and to facilitate the development of problem-solving skills in students (Jiménez-Rodríguez et al., 2020). Therefore, nursing education requires the active participation and engagement of students, in alternative to traditional models focused on knowledge transfer (Jiménez-Rodríguez et al., 2020). The vast majority of undergraduate nursing students belong to the Millennial generation and live immersed in a

predominantly digital world (García-Viola et al., 2019). These students often spend a large proportion of their day interacting with digital technologies, by means of videogames and social media (Martín-Rodríguez et al., 2020). The use of these technologies as a way of living, interacting and learning with each other has transpired to higher education, where students expect to find similar digital methods applied to learning (Martín-Rodríguez et al., 2020). Therefore, the lack of these methods may discourage students from engaging in learning that uses more traditional methods (García-Viola et al., 2019). The

^{*} School of Health and Care Professions, Faculty of Science and Health, St Andrews Court, St Michael's Road, University of Portsmouth, PO1 2FR, United Kingdom of Great Britain and Northern Ireland.

E-mail address: nuno.tavares@port.ac.uk.

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implementation of digital learning methods that facilitate interaction and competition, such as game-based learning, may increase participation and be more attractive to students (García-Viola et al., 2019).

The use of gamification in healthcare professions' education is rapidly increasing (van Gaalen et al., 2021). Despite its common use, there is a lack of shared understanding of what constitutes game-based learning and of why and when gamification should be used in the classroom (van Gaalen et al., 2021). In general terms, the use of game-design elements (e.g. points, leader boards and prizes) to enhance academic performance and learning is known as game-based learning (van Gaalen et al., 2021; Deterding et al., 2011). Although game elements are used to enhance learning, there should be no intention of creating a game. Instead, education remains the primary goal of this approach (van Gaalen et al., 2021). Healthcare simulation can carry some game intention, however simulation does not tend to use game elements (van Gaalen et al., 2021).

The use of active learning methods, such as gamification, in nursing education that promote student engagement and participation are especially important when considering the negative impact of COVID-19 in higher education (Dewart et al., 2020). The pandemic resulted in higher education institutions having to adapt rapidly to delivering teaching and learning sessions virtually, to continue to engage students, whilst ensuring that the learning content and methods were relevant for students and their future professions (Farnell et al., 2021). In fact, game-based learning has been shown to be more effective than traditional teaching methods in improving knowledge retention, motivation and meaningful learning, encouraging critical thinking, decision-making skills and academic performance (Gutierrez-Puertas et al., 2020). However, traditional methods still make up the vast majority of methods used in nursing education and students struggle to engage with these sessions and to keep motivated, even when active learning elements are used (Saeedi and Parvizy, 2019). Therefore, the aim of the literature review is to explore published literature on the use of gamification in the nursing curriculum. The review will explore student experience when using game-based learning, strategies/methods used in the nursing curriculum and understand the impact of these methods on the learning of nursing undergraduate students. The exploratory nature of the review will provide an insight on the current state of literature and highlight the gaps in knowledge in relation to the use of gamification in nursing undergraduate education. To date, there are no published systematic literature reviews exploring this topic.

2. Search strategy

The research question for the literature review was “How has game-based learning been used in the nursing curriculum and what has been its impact on student experience and learning?” In order to identify relevant keywords, the research question was unpicked using the PICO framework (Aslam and Emmanuel, 2010). PICO was defined as the following elements in this review:

- Population – Nursing undergraduate students;
- Intervention – game-based learning in nursing undergraduate education;
- Comparator – not applicable for this review;
- Outcome – the use of game-based learning in nursing education and its impact on student experience and learning.

The keywords and Boolean operators used in the literature search were divided into 2 main themes: nursing students and game-based learning. The keywords and Boolean terms for nursing students included: “student nurse” or “nursing student” or “nursing students” or “student nurse” or “nursing teaching” or “nursing education” or “nurse.” Whereas, the keywords and Boolean terms related to game-based learning were: “game-based learning” or “game-based education” or “gamification.” These 2 themes were combined using the Boolean term

“AND” and relevant literature was searched.

Due to the exploratory character of the literature review, a systematic search strategy was developed, which focused on nursing students and game-based learning. Keywords focused on “student learning” and “student experience” were not used in the search strategy, as it was thought it would restrict the number of papers retrieved.

A total of thirty-five databases available in the EBSCO Discovery Service were searched (Table 1).

The inclusion criteria applied to the literature search can be found in Table 2. The inclusion/exclusion criteria aimed to retrieve up-to-date literature relevant to higher education systems of western societies.

The quality of qualitative and quantitative research papers was evaluated using the CASP checklists relevant to their research methods (CASP, 2021). Papers of poor quality were excluded from the literature review. Data was extracted into a summary of studies table (please refer to Appendix 1) and thematic analysis was used to analyse the data (Kiger and Varpio, 2020). The use of other methods of data analysis, such as meta-analysis, would not be possible due to the exploratory nature of the review, which included qualitative and quantitative research studies. In addition, the lack of quantitative research on the topic and the diversity of game-based learning methods used in published literature would not allow the production of a reliable and informative meta-analysis.

The literature search and review process were monitored by an independent researcher to ensure that all relevant papers were included in the review. Lastly, the systematic literature review follows the *Preferred Reporting Items for Systematic Reviews and Meta-analysis* (PRISMA) guidelines and recommendations (Page et al., 2021).

3. Findings

Seventeen papers from the following countries were included in this review: Spain (8 papers); USA (6 papers); Australia (2 papers); and Malta (1 paper). Please refer to Fig. 1 to find the PRISMA flow diagram. Papers have researched interventions and subjects of increased teaching complexity that required increased levels of knowledge retention and critical thinking, such as nursing theory and complex clinical skills.

3.1. Approaches to game-based learning in nursing undergraduate education

Papers used a wide range of game-based learning approaches to promote student engagement, experience and learning (please refer to Table 3).

Traditional-style quizzes were modernised and game elements were added, in an effort to improve student engagement, learning experience, knowledge retention and consolidation, and the development of clinical skills (such as clinical judgement and decision making). Quizzes incorporated leaderboards (Mackavey and Cron, 2019; Grech and Grech, 2021; García-Viola et al., 2019), time-limited questions (Grech and

Table 1
Databases searched.

eBook Index; Complementary Index; Academic Search Ultimate; MEDLINE; CINAHL; Psychology and Behavioural Sciences Collection; Supplemental Index; Social Sciences Citation Index; Science Citation Index Expanded; Computers & Applied Sciences Complete; Business Source Complete; Scopus®; Dentistry & Oral Sciences Source; Emerald Insight; Academic Search Index; Regional Business News; British Library Document Supply Centre Inside Serials & Conference Proceedings; ERIC; SPORTDiscus with Full Text; APA PsycInfo; Communication & Mass Media Complete; Directory of Open Access Journals; SciELO; eArticle; SAGE Research Methods; SocINDEX with Full Text; Criminal Justice Abstracts with Full Text; Numérique Premium; IEEE Xplore Digital Library; Springer Nature eBooks; Airiti Library eBooks & Journals; Teacher Reference Center; eBook Collection (EBSCOhost); APA PsycArticles; Newswires
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Table 2
Inclusion criteria.

Publication date	January 2017 until 2022
Publication language	English
Location of the Research	Europe, North America, Australia and New Zealand
Methods	Only primary research was included
Population	Nursing students completing an undergraduate degree in a Higher Education Institution
Subjects covered in the papers	Gamification; Nursing students; Education; Learning; Higher education; Nursing education; Teaching methods; Students, nursing; Mobile learning; Student attitudes; Games; Critical thinking; Learning strategies; Virtual reality; Educational games; Active learning; Data analysis software; Game-based learning; Video games; Nursing; Teaching; Educational technology; Motivation; Problem-based learning; Curriculum; Educational outcomes; Meta-analysis; Computer assisted instruction; Medical personnel; Simulation; Student engagement; Students; Ability; Education, nursing; e-Learning; Academic achievement; Escape room; Qualitative research; Questionnaires; Information literacy; Thematic analysis; College students; Flipped classroom; Online education; Systematic reviews; Engagement; Problem solving

Grech, 2021; García-Viola et al., 2019), digital technologies such as Kahoot and Mentimeter (Castro et al., 2019; Grech and Grech, 2021; García-Viola et al., 2019; Wang et al., 2019), and TV-show game

elements (Zehler and Musallam, 2021).

Escape rooms were a common approach to game-based learning. These rooms were a form of collaborative live-action game requiring students to solve puzzles and riddles to escape a locked room, using problem solving skills, critical thinking, and teamwork (Anguas-Gracia et al., 2021). This approach was used to teach clinical skills, consolidate theoretical learning and apply knowledge in simulated healthcare environments (Kubin, 2020). Students were commonly asked to work on case studies and formulate nursing diagnoses and interventions (Anguas-Gracia et al., 2021). In other cases, students were asked to complete puzzles and riddles and progress through different stations, in order to improve the patient's health condition and exit the room (Kubin, 2020; Morrell and Eukel, 2020). In addition to this, escape rooms were also used in the form of assessment tools to evaluate clinical skills, instead of traditional OSCEs (Gutierrez-Puertas et al., 2020; Roman et al., 2020).

A smaller number of papers added game elements to activities that incorporated a variety of active learning methods (Mahaffey, 2019; Jiménez-Rodríguez et al., 2020; Martín-Rodríguez et al., 2020). As an example, Martín-Rodríguez et al. (2020) incorporated game elements, such as leader boards and prizes, into activities that used principles of problem-based learning and team-based learning. Jiménez-Rodríguez et al. (2020) decided to combine game-based learning with other active learning activities when teaching and assessing nursing students. This approach, known as Gymkhana Room for Education and Evaluation in

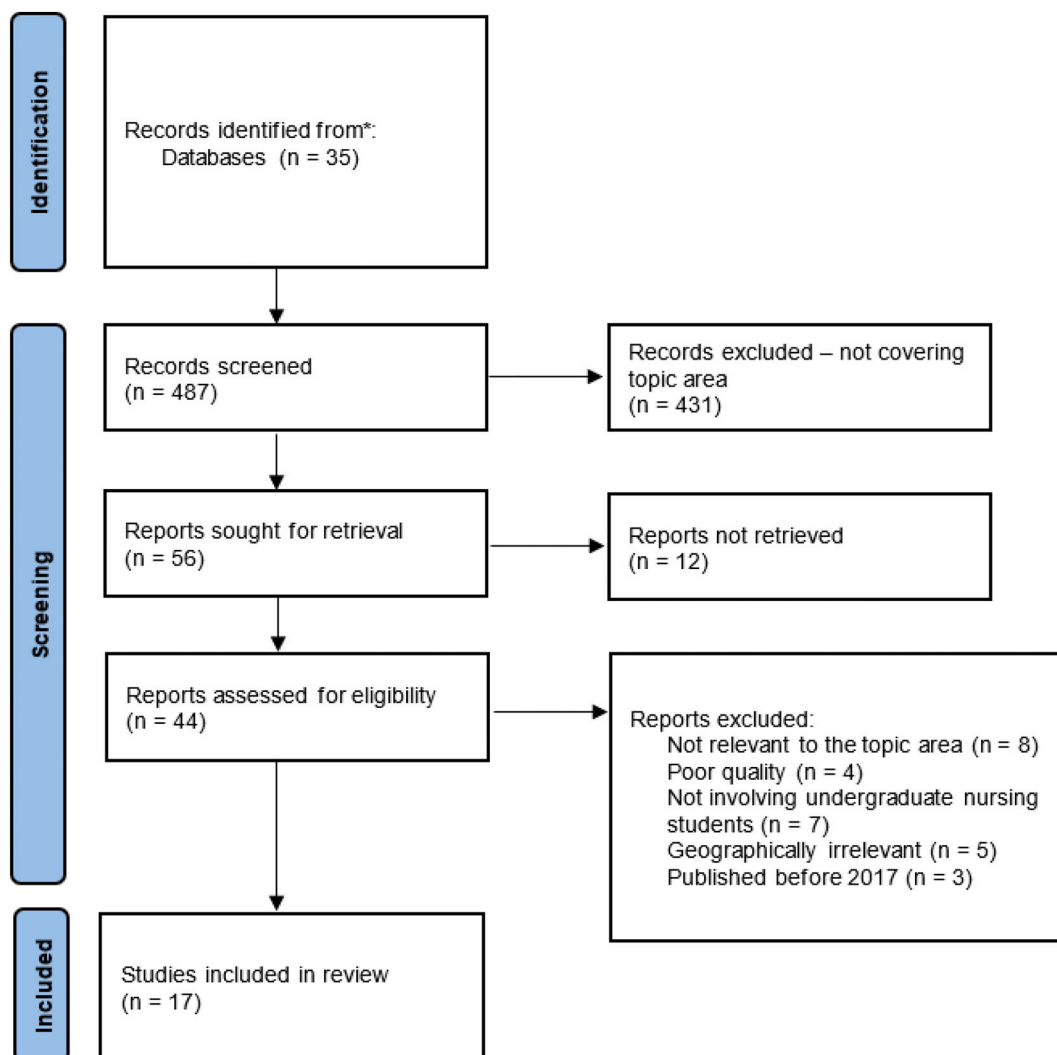


Fig. 1. PRISMA flow diagram.

Table 3
GBL approaches used in the nursing curriculum.

Approach used	Papers
Game-based quizzes (6 papers used this approach)	(Castro et al., 2019) Spain (Mackavey and Cron, 2019) USA (Grech and Grech, 2021) Malta (García-Viola et al., 2019) Spain (Zehler and Musallam, 2021) USA (Wang et al., 2019) - USA (Anguas-Gracia et al., 2021) Spain
Escape rooms (5 papers)	(Gutiérrez-Puertas et al., 2020) Spain Spain (Roman et al., 2020) Spain (Kubin, 2020) USA (Morrell and Eukel, 2020) USA (Mahaffey, 2019) USA
Active learning methods with game elements (3 papers)	(Martín-Rodríguez et al., 2020) Spain (Jiménez-Rodríguez et al., 2020) Spain (Gutiérrez-Puertas et al., 2021) Spain
Phone application with game elements (1 paper)	(Volejnikova-Wenger et al., 2021) Australia
Serious game (1 paper)	(Garnett and Button, 2018) Australia
Digital badges (1 paper)	Australia

Nursing Studies (GREENS), uses game elements to improve student participation and reduce assessment-related anxiety (Jiménez-Rodríguez et al., 2020).

The other three papers combined game elements with digital technologies to promote student learning and motivation. For this, Jimenez-Rodríguez et al. 2020 designed a phone application to promote the learning of basic and advanced life support techniques and compared its impact and use against traditional teaching methods. Volejnikova-Wenger et al. (2021), on the other hand, designed and implemented a serious game (game developed with the sole purpose of training healthcare professionals) to understand its efficacy on the learning of risk assessments of nursing students in community environments. Lastly, Garnett and Button (2018) incorporated the use of digital badges in their online teaching platform to increase student motivation in completing pre-classroom learning packages.

3.2. Student experience and engagement with game-based learning

All papers reported high levels of student experience, engagement and motivation in teaching sessions that used game elements. Only one paper reported similar levels of satisfaction for both game-based and traditional webinars (Grech and Grech, 2021). Despite this, levels of engagement and interaction were higher in the game-based webinar (Grech and Grech, 2021). Students perceived game-based learning as being more successful at facilitating group and team work, at improving student relationships and more enjoyable than non-game-based learning (Roman et al., 2020; Jiménez-Rodríguez et al., 2020; Anguas-Gracia et al., 2021). Students viewed game-based quizzes and escape rooms as innovative and suitable teaching activities that could be used frequently and throughout the nursing curriculum (Castro et al., 2019; Kubin, 2020).

Time-limited escape rooms had positive and negative effects in students' anxiety levels. When escape rooms were used to consolidate and enhance learning, these were seen as stressful activities, which increased students' levels of anxiety (Anguas-Gracia et al., 2021). However, when escape rooms were used to assess students, instead of OSCEs, these assessments were seen as less stressful by students (Roman et al., 2020; Jiménez-Rodríguez et al., 2020). The use of game elements in assessments may reduce students' perception of the importance of the activity, making it more acceptable for students.

Gender differences were also found in game-based learning activities. Male students were more likely to perform at a higher level, to be

more engaged and in having higher levels of control, security and influence when participating in game-based learning activities (Garnett and Button, 2018; García-Viola et al., 2019; Gutiérrez-Puertas et al., 2020). Male students were more likely to play and be interested in recreational games, which may explain their interest in game-based learning (Garnett and Button, 2018). In fact, game experience and good IT skills were considered very important when participating in serious games (Volejnikova-Wenger et al., 2021). Students with less experience and lower levels of IT skills reported disorientation and frustration when navigating through the game (Volejnikova-Wenger et al., 2021).

The long-term use and student interest on game-based learning were only reported in one paper using digital badges to motivate students to complete pre-classroom packages (Garnett and Button, 2018). Findings suggested that interest in earning digital badges decreased week on week until the module finished. At the start of the module, 66 % of participants reported interest in earning digital badges, however only 15 % of participants remained interested in earning badges at the end of the module (Garnett and Button, 2018). Data on the recurrent use of escape rooms or game-based quizzes in the nursing curriculum was lacking.

3.3. Impact of game-based learning on student learning and knowledge retention

Most papers reported on the impact of game-based learning on learning and knowledge retention, however only a small proportion reported on its long-term impact (Castro et al., 2019; Kubin, 2020). Papers suggested that game-based learning had a positive short-term impact on learning, knowledge retention, when compared with usual teaching methods (Morrell and Eukel, 2020; Zehler and Musallam, 2021). However, papers reported mixed results for the long-term impact of game-based learning on knowledge retention, learning and clinical skills. Kubin (2020) and Castro et al. (2019) observed higher scores in the final exam (two months post-intervention) when compared with control groups and/or previous cohorts. However, students that performed well in the game-based activity, performed worse in the final exam (Castro et al., 2019). A possible explanation may include the revision of content by students that performed poorly in the game-based activity (Castro et al., 2019). The activity may have encouraged students to revise specific content before the exam (Castro et al., 2019).

Students valued game-based activities and found these activities helpful when consolidating and conceptualizing content (Kubin, 2020; Volejnikova-Wenger et al., 2021), however some students declined to use these activities when preparing for final exams (Anguas-Gracia et al., 2021).

4. Discussion

The aim of the systematic literature review was to explore the current state of evidence in relation to student experience and learning when using game-based learning and to understand its use in the nursing curriculum. The overall findings suggest that higher education institutions used a wide range of game-based learning approaches to promote student engagement, experience and learning, including gamified quizzes and escape rooms. Student experience, engagement and motivation during gamified teaching sessions was reported to be high and gamified activities improved team work and student relationships. Despite the advantages of game-based learning, papers have also reported some limitations, including increased levels of anxiety in time-limited teaching activities and gender differences during game-based learning activities. Lastly, current literature offered limited insight on the long-term effects of game-based learning and on its widespread use in the nursing curriculum.

Game-based learning is often rated favourably by students, since it encompasses self-determination and motivation theories (Kapp, 2012).

Game-based learning can have an intrinsic motivational character, where students participate in the activity for the enjoyment or achievement it brings; but it can also have an extrinsic motivational aspect, where students participate to obtain a reward, praise or admiration from others (Kapp, 2012). This increased level of motivation leads to better student experience and engagement. In addition, game-based learning is underpinned by self-determination theory, in that it promotes student autonomy and competence (Grech and Grech, 2021). For game-based learning to be successful, students must feel in control of their actions, competent to carry out tasks, and feel related to other students (Grech and Grech, 2021). Time-limited questions, competition and leader boards are important game elements, which help activate student action and encourage students to work under pressure (García-Viola et al., 2019).

High levels of student experience, engagement and motivation during gamified teaching sessions have been observed during on-campus teaching activities, as well as virtual or eLearning activities (Anguas-Gracia et al., 2021; Gutiérrez-Puertas et al., 2021). These findings are significant since the use of eLearning methods, defined as information and communication technologies used to support students to improve their learning (Urh et al., 2015), has exponentially increased since the start of the COVID-19 pandemic (Ropero-Padilla et al., 2021). Higher educational institutions were forced to abruptly change their teaching and assessment methods and rapidly move in-person activities online (Ropero-Padilla et al., 2021). As a consequence, students transitioned from sitting for long hours in the classroom to spending long periods of time in front of computer screens with minimal interaction and limited educational support (McNamara and Bailenson, 2021). The use of game-based learning activities may improve this delivery of online and blended learning programmes, since it encourages team work, increases interaction and improves student relationships (Roman et al., 2020; Jiménez-Rodríguez et al., 2020; Anguas-Gracia et al., 2021). In fact, the effects of game-based learning are considered to be key elements of effective online learning environments, which include contact between students and academics, reciprocity and cooperation, prompt feedback, time on task, active learning techniques, communication of expectations and respect between different student learning approaches (Urh et al., 2015). The added benefits of game-based learning seem to make the case for its wider use in the nursing curricula.

Although game-based learning had a positive impact on student experience, learning and knowledge retention, there were some limitations to its recurrent and widespread use in the nursing curriculum. A key limitation was related to gender differences, where male students were more likely to perform at a higher level and to be more interested in participating in game-based learning than its female counterparts (Garnett and Button, 2018; García-Viola et al., 2019; Gutiérrez-Puertas et al., 2020). This fact is likely to have a greater impact on nursing courses globally, but especially in the UK, since the vast majority of students and nurses are female (Royal College of Nursing, 2019). The frequent and widespread use of game-based learning in nursing education may not be the most suitable approach, when considering the student population. However, at present there is limited information on the recurrent and widespread use of game-based learning in nursing education. Further research could explore in more depth the impact of game-based learning on nursing students, especially on the female student population.

Another limitation may reside in the long-term use of game-based learning. Most papers included in the review did not report or research the long-term impact or use of game-based learning. The only paper that did report on this found that student interest and motivation was lost as the same game elements were used throughout the module (Garnett and Button, 2018). Previous literature has also identified and debated the importance of maintaining student interest and motivation in the long-term, however no strategies were proposed (Bartel and Hagel, 2014; Crocco et al., 2016).

Another limitation of game-based learning relates to student

perceptions about game-based learning itself. Although students saw game-based learning as a suitable and valuable tool in the classroom, some students questioned the usefulness of this approach when revising and preparing for final exams (Anguas-Gracia et al., 2021). Students may associate the use of game elements in learning with recreational games, which makes learning fun (Gutiérrez-Puertas et al., 2020), but removes the seriousness of revising when preparing for exams. Student perceptions need to be considered when implementing game-based learning activities in the nursing curriculum. Clear communication and expectations should be regularly discussed with students.

4.1. Limitations

The systematic literature review drew on recent literature to explore the use and impact of game-based learning in the nursing curriculum. It described methods of game-based learning and analysed its impact on student learning and experience, which can be easily translated to the virtual classroom. Key aspect at times of COVID-19.

A limitation of the literature review was the sole inclusion of English language and primary research literature. Grey literature and non-English language studies, which may have revealed other applications, were not included. However, cross-referencing was performed to reduce the risk of missing out relevant literature. Another limitation of the review was the 5-year publication window, which may have limited the amount of research studies included in the review. However, recent changes in Higher Education produced by the SARS-COV-2 pandemic changed the teaching and learning paradigm for the vast majority of nursing students globally. The current educational context requires the focus on up-to-date and relevant literature that can guide educational practices in Nursing. The use of a wider publication window would result in an increased number of papers reviewed, however, its adequacy and relevance to the current global context would be limited.

5. Conclusion

The literature review described the methods of game-based learning used by higher education institutions across Europe, North-America and Australia. Game-based quizzes and escape rooms were commonly employed when learning clinical skills, developing critical thinking and consolidating learning content. Game-based learning was well accepted by students and seen as being more successful at facilitating group work, at improving student relationships and more enjoyable than non-game-based learning.

Game-based learning produced a positive short-term impact on learning and knowledge retention, whilst the long-term impact of game-based learning on knowledge retention, learning and clinical skills generated mixed results. Lastly, although students valued game-based activities and found these activities helpful when consolidating and conceptualizing content, some students declined to use them when preparing for final exams. Game-based learning can be used to facilitate student engagement, especially at times when only online learning is possible, however student perceptions about game-based learning can impact its widespread use. Future research should focus on exploring the widespread use and long-term impact of game-based learning on the nursing undergraduate curriculum.

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Declaration of competing interest

The authors declare that they have no known competing financial interests or personal relationships that could have appeared to influence the work reported in this paper.

Appendix A. Supplementary data

Supplementary data to this article can be found online at <https://doi.org/10.1016/j.nedt.2022.105484>.

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