JAN JOURNAL OF ADVANCED NURSING

REVIEW PAPER

# Educational gaming in the health sciences: systematic review

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Accepted for publication 13 August 2008

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BLAKELY G., SKIRTON H., COOPER S., ALLUM P. & NELMES P. (2009) Educational gaming in the health sciences: systematic review. *Journal of Advanced Nursing* **65**(2), 259–269
**doi: 10.1111/j.1365-2648.2008.04843.x**

## Abstract

**Title. Educational gaming in the health sciences: systematic review.**

**Aim.** This paper is a report of a review to investigate the use of games to support classroom learning in the health sciences.

**Background.** One aim of education in the health sciences is to enable learners to develop professional competence. Students have a range of learning styles and innovative teaching strategies assist in creating a dynamic learning environment. New attitudes towards experiential learning methods have contributed to the expansion of gaming as a strategy.

**Data sources.** A search for studies published between January 1980 and June 2008 was undertaken, using appropriate search terms. The databases searched were: British Education Index, British Nursing Index, The Cochrane Library, CINAHL-Plus, Medline, PubMed, ERIC, PsychInfo and Australian Education Index.

**Methods.** All publications and theses identified through the search were assessed for relevance. Sixteen papers reporting empirical studies or reviews that involved comparison of gaming with didactic methods were included.

**Results.** The limited research available indicates that, while both traditional didactic methods and gaming have been successful in increasing student knowledge, neither method is clearly more helpful to students. The use of games generally enhances student enjoyment and may improve long-term retention of information.

**Conclusion.** While the use of games can be viewed as a viable teaching strategy, care should be exercised in the use of specific games that have not been assessed objectively. Further research on the use of gaming is needed to enable educators to gaming techniques appropriately for the benefit of students and, ultimately, patients.

**Keywords:** educational gaming, games, health sciences, nursing, systematic review, teaching

## Introduction

One of the aims of higher education for healthcare professionals is to develop practitioners who have the knowledge and skills to enable them to work competently and safely (Shanley 2001). The educational theorist Kolb (1984) developed a four-stage cyclical experiential theory of learning. He argued that knowledge is created through the transformation of experience based on reflection, conceptualization and active planning for new situations, with each individual developing their own learning style. Innovative teaching strategies assist in creating a dynamic learning environment (Bradshaw 2004) and, while the use of games is a strategy employed by many teachers, evidence of their effectiveness as a learning tool is largely anecdotal.

Nurse educators, like many other teachers, are usually required to deliver a specific curriculum. However, as well as making learning enjoyable (Henderson *et al.* 2005), the use of varied teaching strategies can also enhance students' potential. A new attitude towards the concept of experiential learning methods is believed to be the foundation for the expansion of gaming as a strategy (Henry 1997).

Gaming is an historical activity, with archaeological findings providing evidence for the use of games dating back to 3500 BC (Bartfay & Bartfay 1994). The Horizon report (2006) pinpointed educational gaming as a growing field with a substantial contribution to make to adult learning. An educational game is a 'competitive activity with a prescribed setting constrained by rules and regulations' (Allery 2004, p. 504). The learning from such a game results from student interaction and feedback in a comfortable and engaging environment. The positive influences of this format of gaming for nurses were identified by Fuszard (1989) as having seven particular characteristics (see Table 1). However, despite the positive attributes of gaming, potential difficulties can also arise. While enhanced enjoyment and reduction of stress are viewed as constructive aspects (Calliari 1991, Gruending *et al.* 1991), it is also argued that gaming can potentially cause anxiety and embarrassment (Henderson 2005). While games may promote enjoyment and teamwork (Walljasper 1982, Sparber 1990), their use can also result in an increase in competition amongst peers that may be threatening (Henderson 2005).

Despite their increasing popularity, in nurse education preference is given to traditional didactic rather than experiential strategies (De La Cour 1994, Saethang & Kee 1998). There are both positive and negative aspects of using games as a teaching strategy (see Table 2). Although the lecture format may offer the most efficient delivery method of a large amount of information in a limited time, it is argued that this does not promote any critical thinking or necessarily produce effective learners (Odenweller *et al.* 1998).

Ultimately, teaching in the healthcare professions is focussed on educating safe and competent clinical practitioners. The impact of gaming on professional performance and patient outcomes was investigated in a Cochrane review (Akl *et al.* 2008). Because of the strict inclusion criteria with respect to method, this included only one study (Burke 2001), judged to be of 'fair' quality. No firm conclusions were drawn about the long-term impact of games on the performance of healthcare professionals, but further research was strongly recommended.

**Table 1** Seven characteristics of nurses positively influenced by gaming

| |
|---|
| 1. Heterogeneous population – gaming allows the interaction of nurses from different backgrounds to learn from each other's experience |
| 2. Active learning – games promote an active learning style and offer immediate feedback |
| 3. Compassion – nurses need empathy skills to provide support and understanding. Games provide a relaxed environment to develop these abilities |
| 4. Complex work environment – gaming provides opportunities for nurses to understand the intricacies of their work in a controlled atmosphere |
| 5. Time – gaming increases the amount of experiences available compared to other learning formats |
| 6. Motivation – gaming promotes motivational learning through interaction, individual learning and immediate feedback |
| 7. Communication – enhanced through gaming interaction and group discussion |

Modified from Fuszard (1989).

There is a need for evidence to underpin pedagogical strategies in education for healthcare professionals (Royse & Newton 2007). Given the lack of a previous review investigating the comparative outcomes of didactic teaching and gaming across the healthcare professions, we undertook a systematic review of the use of games in health science education.

## Aim of the review

The aim of this review is to investigate the use of games to support classroom learning in the healthcare sciences.

The following questions were addressed:

- How effective is educational gaming as a teaching tool for health science students in comparison to the traditional didactic lecture style?
- Does educational gaming enhance long-term retention of knowledge or skills by the student?
- Is the method of educational gaming a more enjoyable teaching strategy from the student perspective?

## Design

A systematic review of quantitative studies was carried out, using the process described by Higgins and Green (2008). This includes setting clear objectives for the review, formulating selection criteria for the papers, and using a defined search strategy. The critical appraisal skills programme (CASP; Public Health Resource Unit, 2006) for quantitative studies was used to guide the analysis of the studies.

**Table 2** Advantages and disadvantages of gaming

| | |
|---|---|
| Advantages | |
| | Reduction of stress and anxiety |
| | Stimulates interaction |
| | Reduces monotonous lessons |
| | Promotes teamwork |
| | Creates a conductive environment for increased learning and retention of knowledge |
| | Enhances motivation |
| | Promotes a relaxed in the learning environment |
| | Adds entertainment |
| Disadvantages | |
| | Creates stress and embarrassment when incorrect answers given |
| | Can hinder evaluative learning |
| | Competition can be seen as threatening |
| | Cost |
| | Increases difficulty in assessing individual competencies when teams are involved |
| | Requires special preparation which can be time consuming |
| | Requires instruction, and background reading outside of the game to provide a successful technique |

Modified from Henderson (2005), p. 170.

## Search methods

*Search strategy*

Advice was sought from a specialist health librarian about the most suitable databases in which to search for relevant material. Journals that published many of the papers identified via the electronic search, namely 'Medical Teacher' and 'Advances in Physiology Education' were manually searched. Reference lists within relevant papers were inspected to identify supplementary studies. The search was undertaken between May 2007 and January 2008, and was updated in July 2008.

*Databases*

The nine databases searched were: British Education Index, British Nursing Index, Australian Education Index, The Cochrane Library, CINAHLPlus, PsychInfo, ERIC, Medline and PubMed (both initially searched individually but now a combined database).

*Keywords*

Initially the keywords included permutations of 'games', 'health education' and 'teaching tools'. These searches led to a variety of inapplicable papers focusing on sport games and health promotion. Consequently, the keywords were adjusted to include 'educational games', 'health professionals', 'teaching strategies' and 'experiential'. The use of specific terms such as 'nurses' and 'students, nursing' yielded further resources.

*Dates*

Work published from January 1980 to June 2008 was included in the search.

*Inclusion/exclusion criteria*

Eligible papers were those that reported studies:

- Focussed on the use of a specific educational game or games, in comparison to a didactic lecture format.
- Focussed on teaching and learning activities for nursing/health science or medical students aged 18 years or older. No restriction was made in terms of the different branches or specializations within nursing. Studies related to teaching nursing students on either degree or diploma courses, or the equivalent international qualification, were eligible. In addition, studies that incorporated registered nurses as participants undergoing further professional development were included.
- Based on systematic reviews, randomized control trials, experimental pretest/posttest control group design or quasi-experimental structure.
- Using group games such as card or paper-based, board games or interactive team quizzes.
- Undertaken in any country.

Papers were excluded if they were:

- Evaluations of games using a tool such as a questionnaire or survey, as these did not allow comparisons with didactic teaching.
- Reports of computer-based games, as these were more likely to be individual rather than group classroom activities.
- Not available in English.

## Search outcome

The search initially produced a total of 1829 potential papers. The full study selection process is described in Figure 1. As indicated, 16 research papers remained for analysis.

## Quality appraisal

Details of the eligible papers were extracted using the criteria suggested by the CASP (Public Health Resource Unit, 2006). Focus was directed towards the specific design chosen for the study, the number of participants and when possible their demographic characteristics, the particular intervention used for the study (in this case the game format), and the statistical analysis of the results. Quality indicators of the eligible original studies are presented in Table 3. These specify the key factors reviewed for critical analysis of the papers. As there is a paucity of literature on this topic, we included all 16 papers identified, regardless of quality.

 

### Data abstraction and synthesis

A meta-analysis was not appropriate (due to the variation in settings, methods and samples in the studies reviewed); therefore the findings are presented here in narrative form. Two of the studies included responses in free text format (on student enjoyment), but these were relatively small components of those studies and the findings have been summarized in the narrative.

A table was prepared using the established criteria for inclusion into the study. Only those studies that satisfied the criteria were analysed. Data from all the original studies in the review were entered into the Table 3 to facilitate comparisons and enable the quality to be assessed.

## Results

All studies identified were published between 1980 and 2007. One paper reported a Cochrane review (Bhoopathi & Sheoran 2006) which included only one study (Kelly 1995) that was also retrieved through our search. Ten studies were based on experimental designs and four on quasi-experimental methods. Overall, the selection incorporated studies reported in three dissertations (Sprengel 1992, Burke 2001, Montpas 2004), one Master of Science thesis (Jungman 1991), 10 peer-reviewed journal papers and a Cochrane review.

The sample size in the studies ranged from 16 to 237. Nine of the studies focussed directly on nursing professionals, namely undergraduate and graduate nursing degree students and registered nurses in fields of paediatric, psychiatric and adult nursing. Occupational therapy students and healthcare workers were represented in two of the studies (Roberts 1993, Burke 2001). One study related to medical neurology residents (Schuh *et al.* 2008) and the remaining three all involved medical students as participants (Fukuchi *et al.* 2000, O'Leary *et al.* 2005, Da Rosa *et al.* 2006).

The interventions used in the studies all represent a particular game format. In seven trials team quizzes were conducted; three in a question and answer configuration, one as a drawing competition and four based on TV game shows. Two studies involved the use of card games, four involved board games and in one paper there was no description of the game format employed (Roberts 1993).

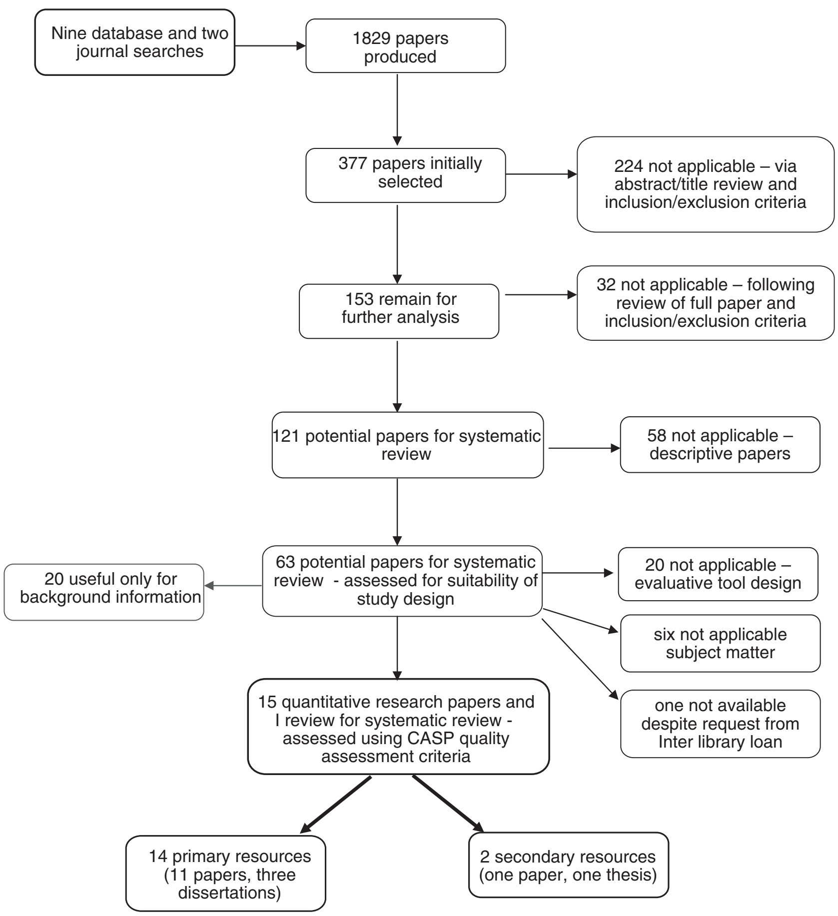


**Figure 1** Flow diagram of the study selection process.

**Table 3** Quality indicators for included studies

| Reference | Method | Intervention | Hypothesis given | Sample size | Sample size calculated | Method of randomization | Baseline comparability of groups given | Analysis |
|---|---|---|---|---|---|---|---|---|
| Bays and Herman (1997) | Experimental control group design | Team drawing quiz | Yes | 69 | Not stated | Not given | Yes | Confidence interval α = 0·05 |
| Burke (2001) | Experimental control group design – pretest/posttest | Question and answer timed quiz | Yes | 237 | Not stated | Via employee badge numbers | Yes | Confidence interval α = 0·05 |
| Cessario (1987) | Quasi-experimental design – pretest/posttest | Board game | No | 23 | Not stated | Drawing a number from a bag | Briefly given | Confidence interval α = 0·05 |
| Cowen and Tesh (2002) | Quasi-experimental study | Question and answer quiz | No | 85 | Not stated | Via time of enrolment | Not given | Confidence interval α not given |
| Da Rosa *et al.* (2006) | Experimental – pretest/posttest design | Card game | No | 140 | Not stated | No details given | Not given | Confidence interval α = 0·05 |
| French (1980) | Experimental test – pretest/posttest | Card game | Yes | 87 | Not stated | No details given | Yes | Confidence interval α = 0·01 |
| Fukuchi *et al.* (2000) | Pretest/posttest design | Board and computer game | No | 16 | Not stated | Not given | No details given | Confidence interval α = 0·05 |
| Jungman (1991) | Quasi-experimental design – using 2 groups of subjects | Board game | Yes | 60 | Not stated | Could not be randomized | Yes | Confidence interval α = 0·05 |
| Kelly (1995) | Experimental control group design – pretest/posttest | Board game | No | Not stated | Not stated | No details given | No details given | Confidence interval α not given |
| Montpas (2004) | Quasi- experimental, pretest/posttest, longitudinal design | Team quiz based on TV show | Yes | 68 | Not stated | According to which course enrolled in | Yes | Confidence interval not given α = 0·05 |
| O'Leary *et al.* (2005) | Pretest/posttest design, with experimental and control groups | Team quiz based on TV show | No | 104 | Power analysis | Random number tables | No details given | Confidence interval α = 0·001 |
| Roberts (1993) | Pretest/posttest | Not stated | No | 179 (split over 2 sections) | Not stated | Random number tables | No details given | Confidence interval α = 0·05 |
| Schuh *et al.* (2008) | Quasi-experimental pretest/posttest design | Game show type quiz | Yes | 37 | Not stated | No randomization, prospective intervention group compared with historic controls | Yes | Confidence interval α = 0·05 |
| Sealover and Henderson (2005) | Pretest/posttest design with an evaluation | Team quiz based on TV show | Yes | 107 | Not stated | No randomization as all participated in games | No details given | Confidence interval not given α not given |
| Sprengel (1992) | Experimental design with posttest | Question and answer team game | Yes | 41 | Not stated | Via their identification numbers | Yes | Confidence interval α not given |

In two trials only a posttest analysis of knowledge was completed by students (Sprengel 1992, Bays & Herman 1997). Sprengel (1992) investigated whether participation in gaming increased student knowledge, compared to straightforward discussion. In that study, all of the class completed a learning style review followed by 6 hours of didactic teaching. The experimental group then completed a 2-hour gaming session and the control group reviewed the topic via discussion. Five days later, a posttest was completed by students.

Bays and Herman (1997) followed a different format. Their class was provided with a content outline of the topic 1 week prior to the teaching session. On the day of the session the experimental group received a lecture then a game instruction, and the control group a lecture and discussion. The effectiveness of the methods was then assessed via students' scores for that unit of the course and a final examination.

The remaining 12 studies all followed the pre/posttest analysis configuration. In five of these, the pretest and posttest was conducted immediately before and after the teaching session (French 1980, Fukuchi *et al.* 2000, O'Leary *et al.* 2005, Sealover & Henderson 2005, Da Rosa *et al.* 2006). French (1980) and O'Leary *et al.* (2005) followed this basic format using an experimental and control group. Fukuchi *et al.* (2000) produced a study in which all subjects participated with the game. They constructed an elimination tournament therefore, their participants completed the posttest after either 1 or 2 rounds. Sealover and Henderson (2005) and Da Rosa *et al.* (2006) did not randomize their students into either a treatment and control group; all of their participants participated in the gaming session.

In three studies student participants completed a pretest and a delayed single posttest (Cessario 1987, Jungman 1991, Cowen & Tesh 2002). Cowen and Tesh (2002) administered a pretest 1 week prior to the teaching session and a posttest 1 day afterwards. Cessario's (1987) study had two gaming sessions 1 week apart, and then a posttest completed 3 weeks later. Finally, Jungman (1991) conducted a study over a semester, incorporating weekly 3-hour lectures and 2-hour laboratory time with/without gaming, depending on group assignment. The posttest was completed at the end of the semester.

In three trials, a pretest was conducted with multiple posttests (Roberts 1993, Burke 2001, Montpas 2004). Montpas (2004) used an experimental and control group design with an immediate posttest and a delayed test two weeks later. Roberts (1993) employed a similar design, but in addition to the immediate posttest delayed posttests were held 2, 6 and 8 weeks later. Finally, Burke's (2001) study had a different structure, examining gaming as a reinforcement strategy 1 month after an initial teaching session involving either a self-learning module or videotaped instruction. An immediate posttest was administered after the initial instruction and another test was held following the reinforcement strategy.

In the study by Schuh *et al.* (2008), neurology residents were given post-session team quizzes. In-service examination scores (before and after the period of study in which the intervention was or was not delivered) and US Medical Licensing Examination scores of the 17 participants were compared with the scores of the 'control' group, 20 residents who had previously undergone a didactic programme.

The authors of the final study (Kelly 1995), although following a pretest–posttest experimental design, did not give any confirmation of the timings of their pre- and posttest examinations. This is the only study included in the Cochrane review of the use of games for teaching mental health students (Bhoopathi & Sheoran 2006). The conclusion of the review is that the quality is fair because, although randomization occurred, the precise method of allocation of students is not reported.

In addition to the pre/posttest design, in eight of the 14 studies participants were asked to complete a questionnaire/evaluative survey. Da Rosa *et al.* (2006) used a questionnaire to establish the effectiveness of their educational tool. Cessario (1987) also used a questionnaire, but placed a particular focus on the experimental group's opinion of the game to determine their motivation and enjoyment levels. French (1980) conducted a similar survey to analyse enjoyment levels as well as to review learning style preferences.

Authors of four of the remaining studies primarily employed Likert scales in questionnaires to assess the impact of the game (Fukuchi *et al.* 2000), as a satisfaction survey (Roberts 1993, O'Leary *et al.* 2005), and to understand the perceived uses of the gaming strategy (Sealover & Henderson 2005). Finally, Sprengel (1992) devised an evaluative questionnaire to obtain descriptive data on the alleged worth of the game or study guide session used. Kelly (1995) also used an evaluative tool, but this was administered via semi-structured interviews.

### Outcomes in relation to the research questions

The three original questions posed in this review provide the structure for the presentation of the results. In each instance, the experimental group represented those who experienced educational gaming and the control group corresponded to those who experienced only the traditional or usual teaching method, e.g. lectures, discussion groups or self-learning.

 

*Question 1. How effective is educational gaming as a teaching tool for health science students in comparison to the traditional didactic lecture style?*

Two papers, by Sprengel (1992) and Bays and Herman (1997), only reported a posttest analysis of student scores. In the first study, although the experimental group had a higher percentage of correct scores, ANOVA indicated that this difference was statistically insignificant [$F(1,35) = 2·23$, $P < 0·15$]. In the latter study, a *t*-test was used and this demonstrated no statistically significant difference between the experimental and control groups.

The studies by Cessario (1987), Jungman (1991) and Cowen and Tesh (2002) consisted of a pretest and one delayed posttest. Cessario's (1987) results showed that the experimental group performed statistically significantly better than the control group ($P < 0·05$), while Jungman (1991) found that the experimental group's pretest score means were statistically significantly higher than those of the control group ($t = 6·3765$, reported as $P = 0·000$ in the original paper). However, the groups did not differ statistically significantly with respect to the mean change in posttest and pretest scores ($t = -1·2151$, $P = 0·2293$). Cowen and Tesh's (2002) paper demonstrated no statistically significant difference between the pretest scores, but the posttest scores for both groups were higher, with a statistically significantly better difference in the experimental group [$F(1,82) = 15·68$, $P = 0·0002$].

Roberts (1993) and Montpas (2004) used a pretest and multiple posttest design. In the Roberts (1993) study, four experiments were conducted and these produced mixed results. Of a total of 16 results, two were statistically significant in favour of the control group and two in favour of the experimental group. In the remaining experiments no statistically significant differences were demonstrated. Using an independent *t*-test, no statistically significant difference in pretest scores was shown in Montpas's (2004) study. A paired *t*-test demonstrated an increase in posttest scores for both groups and an independent *t*-test showed a statistically significant difference between posttest mean scores ($P = 0·000$) in favour of the lecture group.

Scores from tests undertaken at regular intervals throughout the period of residency training were analysed by Schuh *et al.* (2008). There were no differences in baseline scores ($P = 0·11$), calculated using US Medical Licensing Examination step 1 results, but the data for this analysis were only available for 10 controls and 15 in the intervention group. Both teaching methods resulted in increased knowledge. The historic control group scores were compared with those of the intervention group using paired *t*-tests, and the intervention group scored statistically significantly higher ($P = 0·0002$). Those in the intervention group also improved more than those in the control group ($P < 0·001$).

The five remaining studies had a design incorporating a pretest followed immediately by a posttest. In 1980, French demonstrated (using an independent *t*-test) that there was a statistically significant difference in scores for all but one of their experimental groups in comparison with the control group ($P < 0·01$). Fukuchi *et al.*'s (2000) study produced diverse results: a paired *t*-test following one round of their game gave non-statistically significant results, whereas after two rounds the results were statistically significant. The two studies O'Leary *et al.* (2005) and Sealover & Henderson (2005) showed that both teaching methods statistically significantly increased knowledge. The analysis of Sealover and Henderson's (2005) prepost and posttest results showed a statistically significant improvement on the group mean pretest to posttest. Finally, Da Rosa *et al.*'s (2006) study established that the game statistically significantly improved knowledge, but there was no statistically significant difference between the two gaming groups.

Kelly's (1995) report gave no details of the timings of their pre- and posttests, but did show that the experimental group's scores improved statistically significantly in the posttest ($P \leq 0·005$) whereas the control group's scores demonstrated no statistically significant change ($P < 0·1$). Bhoopathi and Sheoran (2006) concluded from their review that the study by Kelly demonstrated that the use of games was helpful in supporting learning by mental health students in the short term, but that the work should be replicated to increase the evidence base.

*Question 2. Does educational gaming enhance long-term retention?*

Three studies used a single delayed posttest analysis (Cessario 1987, Jungman 1991, Cowen & Tesh 2002), at 3 weeks, at 1 day and at the end of the semester respectively. Cessario (1987) demonstrated that the experimental group statistically significantly outperformed the control group ($P < 0·05$) 3 weeks after the session. Jungman's (1991) posttest analysis showed that the experimental and control groups did not differ statistically significantly after a day. Cowen and Tesh (2002) verified that posttest scores were higher in both groups, but were statistically significantly greater in the experimental group.

Four studies involved multiple posttests to investigate long-term retention of information (Roberts 1993, Fukuchi *et al.* 2000, Burke 2001, Montpas 2004). Roberts (1993) conducted four separate experiments. For one group, the posttest was conducted 2 weeks after the pretest examination and no statistically significant difference in results was noted, but the control group's loss of knowledge was greater. Two of the other groups showed no statistically significant difference in results after 6- and 8-week posttest analyses. The final group showed a statistically significant difference in favour of the experimental group at 8-week posttest. Fukuchi *et al.* (2000) completed a linear regression analysis to determine the correlation between the number of questions answered correctly, against the number of games played (one or two rounds of the elimination game were played at the same sitting), and a positive relationship was shown ($P < 0{\cdot}001$). Burke (2001) determined that game-based reinforcement had a marginally positive effect on a delayed posttest for a self-learning group and a video group, with the self-learning group scoring statistically significantly higher. Finally, Montpas (2004) completed a comprehensive posttest analysis, reviewing 'Gain 1' as the difference between posttest1 and the pretest, and 'Gain 2' similarly for posttest2. An independent *t*-test showed a statistically significantly higher result for the control compared to the experimental group for 'Gain 1'. A paired *t*-test showed that 'Gain 2' was statistically significant for the control but not the experimental group, there was a statistically significant difference between the groups for their posttest2 scores in favour of the control group, and a paired *t*-test showed that the posttest2 scores were statistically significantly lower than posttest1 for the control but not for experimental group. In addition, there was no statistically significant difference in 'Gain 2' between the groups. Overall, the average change on gain of scores ('Gain1' − 'Gain2') was statistically significant ($t = 2{\cdot}788$, $P = 0{\cdot}007$) in favour of the experimental group.

The finding of the review (Bhoopathi & Sheoran 2006) was that games were useful for improving short-term knowledge retention, but that there was no evidence for improving knowledge in the long-term.

*Question 3. Is educational gaming a more enjoyable teaching strategy for students than didactic lectures?*

Nine of the reviewed studies involved a supplementary evaluative assessment of the learning styles used. Da Rosa *et al.* (2006) employed a questionnaire to determine the effectiveness of the educational tool, and remarked that the overall response was positive. Cessario (1987) concluded from a board game questionnaire that the response rates of their experimental group showed that the game not only motivated learning but reinforced it, with the suggestion that such a format should be included in the course. Fukuchi *et al.* (2000) remarked that students thought that they improved their understanding of the subject in three specific topical areas, while Kelly (1995) conducted semi-structured interviews with the experimental group and reported that students believed that the fun and competition of the game enabled learning to become an interactive and non-threatening process.

Participants in the study by French (1980) completed a questionnaire in which the ranking of the learning methods was subjected to Friedman's 2-way analysis of variance, resulting in a highly statistically significant result ($P < 0{\cdot}00001$), placing gaming first and lectures second. A binomial test to compare each of the five learning methods used in the study showed that there was no preference between the game and lecture method, but they were both preferred to the other methods.

Participants in two studies completed a questionnaire using a Likert scale (Roberts 1993, Sealover & Henderson 2005). Roberts (1993) determined enjoyment levels using a Mann–Whitney test. In one of the experiments there was no statistically significant difference, but participants in the other three were statistically significantly in favour of the experimental group. Sealover and Henderson's (2005) instrument produced positive evaluations by the experimental group, but additional written feedback gave negative views.

Finally, two researchers used a chi-square assessment (Sprengel 1992, O'Leary *et al.* 2005). Sprengel (1992) compared the percentage of participants who reacted favourably with those who reacted unfavourably to their participation method. Non-statistically significant results were found for the non-threatening environment, specific enjoyment and motivation for each method. However, gaming narrative responses were all positive, and both groups wanted more of the specific learning strategy used in the course. O'Leary *et al.* (2005) used a survey completed by 93% of participants, which resulted in a positive response for the experimental group with reference to the stimulating format, knowledge retention and enjoyment levels ($P < 0{\cdot}001$), compared to the control group. A Likert scale also produced statistically significantly positive responses.

## Discussion

This review focussed on the use of games in health professional education, as many topics and skills related to competent practice are common to a range of professions. While sharing of evidence across professions is appropriate in some respects, the breadth of the search could be viewed as a limitation to the review in that it did not specifically address the needs of any one professional group.

The facilitation of learning for nursing students is recognized as a challenge to nursing educators (Jungman 1991). While innovative techniques involving the use of games are used, assessment of the use of the games in enhancing learning is not well-researched. In a search of health professions-related literature for the last 40 years, over 100 published games were discovered; however, only 15 original

## What is already known about this topic

- Students have a range of learning styles.
- Innovative strategies to facilitate learning are being used by educators in nursing, medicine and the health sciences.
- There may be both advantages and disadvantages to using games as a teaching strategy.

## What this paper adds

- The use of games may reinforces the knowledge and skills learnt by students.
- Students have both positive and negative attitudes to the use of games, suggesting that games may support the learning styles of some students, but not others.
- Games are used in the learning environment without sufficient evidence of benefit to learners.

## Implications for practice and/or policy

- In educational settings, games can support the long-term retention of information that is necessary for safe clinical practice.
- Educators should not assume that all students find games enjoyable.
- Further research, using more rigorous methods, is needed to establish the utility of classroom games.

studies evaluating games as a learning tool were found for this review, and the methodological basis of those papers was poor to fair. In most cases, data such as confidence intervals and effect sizes were not reported, making assessment of the impact of the game difficult. These findings are supported by the inclusion of only one study in the Cochrane review on the topic (Bhoopathi & Sheoran 2006), although that review was limited to mental health students. This suggests that, in most cases, games are introduced with insufficient objective evaluation of their value to learners. Importantly, our review has shown that neither gaming nor didactic teaching strategies are detrimental to learning in the student cohorts involved in the studies analysed. However, the sample sizes of some of the studies were not necessarily large enough to ensure validity of the results, with nine researchers recruiting fewer than 100 participants. Furthermore, when an experimental and control group design was used, baseline comparability of the groups was often overlooked, with only seven papers providing the relevant information. This was also a finding of Bhoopathi and Sheoran (2006), who strongly recommended that the innovative work by Kelly (1995) was taken further.

Our review suggests that, where evaluation does occur, the effectiveness of educational gaming as a teaching tool varies. This variation in results is expected due to the range of games used, the different student cohorts and the methods used to assess the effectiveness of the games. In general, however, higher levels of postsession knowledge were demonstrated in students exposed to game interventions when compared to control groups.

While immediate acquisition of knowledge is relevant, it is long-term retention of information that is of greater interest (Sprengel 1992). This is of particular importance when teaching students of the healthcare professions who will require this knowledge to practise safely (Montpas 2004). The longer-term retention of information was examined in seven studies through individual or multiple delayed posttests. Although timing of posttests varied enormously, game-based reinforcement generally had a positive effect on scores. However, non- statistically significant results were also identified in a 1-day posttest design (Jungman 1991) and in two other studies with a more complex analysis (Roberts 1993, Montpas 2004).

The experience of students in the learning environment has been shown to have an impact on their overall learning (Jungman 1991). Where students' experiences in using gaming as a learning strategy were evaluated, overall responses were positive, highlighting motivation, competition and the gaming's non-threatening stance as key factors. When statistical analysis was done, some statistically significant results emerged in favour of gaming. However, it must be noted that written feedback from students also included negative responses, indicating perhaps that for some the strategies are not helpful.

One relevant issue is the weakness of many of the studies reviewed in terms of design and methods. For example, the use in three studies of a convenience sample consisting of one cohort of nursing students seriously limits the generalizability of the findings. In other studies, lack of information about the randomization strategy means that the findings may be due to differences in cohorts rather than the intervention.

## Conclusion

This review has indicated that the available research on use of games as an educational strategy is inadequate to enable judgements to be made about the effectiveness of such strategies in preparing healthcare professionals for practice. In order to establish whether or not the use of a specific game is helpful to students, more attention needs to be paid to study design, while sample size should be based on power calculations. A broader approach involving multiple student cohorts, teachers and settings would help to ensure that the effects of confounding variables (e.g. particular teaching styles) are reduced to a minimum, while randomization would help to ensure rigour. An important aspect of any such studies would be the establishment of baseline levels of knowledge or skill in both control and experimental groups so that differences in knowledge can be compared within as well as between groups. Well-designed studies would facilitate meta-analysis of the data, providing educators with a sound evidence base to inform their pedagogical practice in the use of games.

Ultimately, the test of educational strategies must lie with their impact on patient care but there has been little or no work in this area, indicating a need for more creative research linking the use of games with patient outcomes. In addition, qualitative studies would help to clarify the positive and negative aspects of gaming from students' perspectives.

The limited research available indicates gaming may be effective in enhancing student learning and does not appear to be detrimental. However, care should be exercised in the use of games that have not been assessed objectively. Based on this review, it would seem that gaming makes a positive contribution to the learning process and it seems appropriate to recommend that teachers continue to use games as one aspect of their teaching. Robust research is needed to inform educators fully so they are able to use gaming techniques appropriately for the benefit of students and, ultimately, patients.

## Author contributions

GB, HS, SC, PA & PN were responsible for the study conception and design. GB performed the data collection. GB & HS performed the data analysis. GB & HS were responsible for the drafting of the manuscript. SC, PA & PN made critical revisions to the paper for important intellectual content. GB provided statistical expertise. HS & SC obtained funding. GB provided administrative, technical or material support. HS & SC supervised the study.

## Funding

The study was funded by a grant from the University of Plymouth, UK.

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