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Research Article

Will The Use of Game-Based Learning Improve Long-Term Recall in Physician Assistant Education?

Claudine Ruzga[1], Randy Brush[1]*, Jessica Bruskoski[1], Nicole Joy[1], Jana Stedman[1], Rami Musleh[1], Denise Rizzolo[2]

[1]Master of Science in Physician Assistant Studies (MSPA)/Valparaiso University, Valparaiso, Indiana, United States

[2]College of Health Sciences and Public Policy, Walden University, USA

*Corresponding author: Randy Brush, Master of Science in Physician Assistant Studies (MSPA)/Valparaiso University, Valparaiso, Indiana, United States

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Abstract

This review investigates the efficacy of gamification and game-based learning methods in enhancing long-term knowledge retention within physician assistant education. As technological integration in education rises, these methods, including serious games, virtual reality **(VR),** and game-based learning, have gained attention for their potential to improve student engagement and retention. A comprehensive review of 14 randomized clinical trials conducted over the past decade was undertaken to evaluate the effectiveness of these pedagogical tools compared to traditional teaching methods. Results from studies on board games, VR, serious games, and game-based learning revealed mixed outcomes. While some studies demonstrated improved student engagement, motivation, and participation, the evidence for improved long-term knowledge retention was less conclusive. For instance, VR-based learning in medical workshops showed increased interest and motivation, though knowledge retention did not significantly surpass traditional methods. Similarly, serious games were noted for their engaging nature but failed to consistently outperform traditional pedagogical strategies in terms of retention. Despite these findings, gamification was generally well-received by students, particularly in smaller groups, although larger groups experienced diminished effectiveness. The review also highlighted the potential drawbacks, including the cost of implementation and the complexity of certain game-based systems. Overall, gamification and game-based learning methods appear to enhance student motivation and engagement; however, current evidence does not conclusively support improvements in long-term knowledge retention. Therefore, further large-scale, standardized studies are necessary to better assess their educational value and cost-effectiveness in physician assistant training

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Keywords: Gamification; Education; Physician Assistant; Game-Based Learning

Introduction

Over the past decade, an increase in the study of pedagogical methods in physician assistant education has been observed. Gamification is a term that has been used more frequently in the research of short and long-term knowledge retention. However, gamification as a term needs to be first defined so it is used consistently in research. Gamification broadly refers to the application of game elements-such as points, badges, and leader boards-in non-gaming contexts to increase engagement, motivation, and participation in learning. In educational settings, it aims to make the learning process more interactive and enjoyable.

Several related terms often appear in the literature and should be clearly distinguished. Game-based learning involves teaching through structured games aligned with course objectives. Serious games are designed for training or behavioural change, and virtual reality **(VR)** offers immersive, interactive simulations of real-world environments. Clear definitions of these terms are essential for interpreting results across studies.

The generation of students that are now entering physician assistant programs was raised using technology to learn new material starting at a young age. With the widespread use of games to learn to count and to learn colours through e-learning, it is imperative to find out if gamification and other methods like game-based learning will help improve the long-term retention of knowledge in physician assistant students.

Literature Review Methods

A review of the literature was conducted using databases including PubMed and Valparaiso University Library, which has multiple online databases. The search was conducted for randomized clinical trials that are peer-reviewed journal articles in English, performed in the past 10 years. ("Gamification", "serious games", "game-based learning" and "medical education") Fourteen out of sixty randomized clinical trials were selected that compared a type of gamification or game-based learning and traditional pedagogical methods to determine if the evidence substantiated using gamification in physician assistant education to enhance long-term knowledge retention. The randomized trials were included only if they studied learning in health sciences or medical education. Excluded were trials that did not have a control group with traditional teaching methods. Studies were only included if they had been conducted in the last 10 years. After selecting 14 randomized clinical trials that fit these criteria, each study was analysed to determine if there was any statistically significant data to promote the use of gamification in medical education to improve long-term knowledge retention.

Literature Review Results

Board Games

The first group of studies evaluated the use of board games versus traditional teaching methods using lectures. In a study of 124 third-year medical students, one group was assigned to a 75-minute lecture only and the other group was assigned to a 75-minute board game with learning questions whose answers caused them to move forward or backward on the game board based on correct answers for their upcoming basic medical pharmacology final exam [1]. The pre-test and post-test scores in the two groups differed slightly whereas, in the immediate post-test, the board game group received 3.5 points and the lecture-only group received 2.8 points. This suggested no statistically significant difference was found between learning outcomes at the immediate post-educational learning session. Long-term retention of knowledge was tested on average at 14 days after the activities. The mean ratio of correct answers was higher in the board game group (0.673) versus the lecture-based group (0.647) [2].

Another study paired the use of board games against a control that had a more interactive lecture. This study included 42 students who either had 12 hours of interactive instruction which included engaging the class with the use of question-answer activities on basic and applied sciences over 2 consecutive days or 12 hours of board games over 2 consecutive days to learn the same material. The board game was designed by the group performing the study. It contained questions in 4 topic areas and there was a deck of 150 cards. It consisted of rolling dice and moving forward when questions were answered correctly. They repeated the game each time someone completed the board until the time was finished. This study found the difference between a pre-test and post-test score on a 40-point examination was a 29.5% increase in the board game group and a 31.5% increase in the interactive lecture group, which was not statistically significant. Both groups found the learning activities equally effective, engaging, and enjoyable on a post-activity survey [3].

Virtual Reality

The next group of randomized clinical trials used virtual reality **(VR)** types of learning. In a study of 18 students4, textbook reading, single-player VR, and multi-player VR were compared when learning anatomy and physiology. They tested knowledge scores on the three groups on day 1, day 5, and day 12 of a 5-day instruction period. This resulted in increased knowledge scores on day 12 in both the single-player and multi-player VR groups compared to traditional textbook learning. It was also noted that the VR groups had increased interest, competence, motivation, and

fun using VR. Unfortunately, increased stress was also noted in the multi-player VR group [4].

A larger study included 215 third-year medical students who were assigned either to a virtual or 3D classroom versus a real-life classroom to attend the same workshop for abdominal X-ray interpretation. They were given a 12-question multiple-choice exam before the activity and 2 months later. They were assigned to seven 2-hour workshops either in person or in the virtual world. All sessions were conducted by the same instructor. In the virtual world, the students participated via written chat for short answers and voice chat for longer answers. When post-activity knowledge scores were evaluated, no statistically significant differences between the two groups were found (6.2 +/- 1.2 points in the VR group versus 6.0 +/- 1.7 in the control group). However, increased participation in the VR group was noted over the control group [5].

A recent study compared VR with lecture instruction in 50 medical students who were learning the medical management of a patient in a coma. This study only investigated immediate learning outcomes and did not include a long-term evaluation of knowledge retention. It did show a statistically significant improvement in immediate scores in a 10-question post-test compared to students who received a traditional lecture. The post-test mean for the VR group was 14.05 +/- 1.27, whereas the control group had a post-test mean score of 12.02 +/- 3.45 [6].

Serious Games

Serious games was another category of randomized clinical trials that were evaluated for efficacy in medical education. In the first study of 27 undergraduate medical students, a serious game versus traditional instruction was reviewed as a potential learning method when studying primary health education. This study compared a pre-test, immediate post-test and long-term retention test after 4 weeks containing multiple choice type questions that were the same on all 3 tests. No differences between the two groups were found. It was concluded to be as effective as traditional instruction for a learning method, but not better for long-term knowledge retention [7].

In another study, the effect of serious game use on clinical reasoning skills was compared to a traditional reading assignment with power-points and lectures. A total of 146 second-year nursing students participated. The serious game group used a timed approach, and they participated in four virtual clinical cases where the nurse had to identify clinical deterioration in four different scenarios and communicate appropriately. This was compared to nursing students learning the material on a paper script that was discussed and some power point presentations. Immediate and long-term evaluation of clinical reasoning skills using script concordance tests **(SCT)** were given immediately and one month after the lesson was completed. The SCT for the serious game was 58.9 +/- 9.1 immediately after and 58.5 +/- 10.2 after one month. The control group's SCT scores were 57.8 +/- 8 and 58 +/- 9.1 immediately and one month later. No difference in skill scores between the two groups was noted [8].

Serious games and traditional lectures were assessed for the development of clinical skills in 103 nursing students that were being trained to give blood transfusions. In the study, students were given a knowledge test and a performance test. The results of the knowledge test showed an immediate increase in scores with the serious game group, but it did not show any change in the performance skill test at 2 weeks post instruction [9].

Another study evaluated triage skills in 117 pharmacy students using text-based scenarios **(TBS)** versus serious games **(SG)** scenarios. In the TBS group, the students followed a linear path through the learning objective with feedback after each step despite the correctness of their answer. The SG group followed different paths depending on their answers, but the paths would eventually cover all the steps and the student would get all the feedback by the end of the game activity. Students favoured serious game learning over traditional text-based scenarios, but no difference was shown in the outcome of their clinical knowledge scores of SG 7.07 and TBS 6.81 [10].

The final study comparing app-based serious games and traditional instruction evaluated a technical skill versus knowledge. There were 116 medical students enrolled. They evaluated the ability to perform a chest tube insertion. The serious game group performed the skill more efficiently, with less assistance, and with better technique than the control group with overall scores of 38 versus the control group with scores of 30.5 [11].

Game-Based Learning

Two randomized clinical trials that included computer-based games as a type of pedagogical method were also evaluated. In the first study, which was conducted in 2013, an assessment of anatomy and physiology in 29 speech pathology students was conducted. In this small cohort, immediate and long-term knowledge retention at 6 months was evaluated. They were divided into a group that had a computer game-based learning method and a group that had a traditional learning method. Both methods had the same duration and the same tutor. The content was delivered one hour per week for 9 weeks. The computer game-based learning group took animated quizzes on the computer weekly with immediate feedback after the questions. The traditional group was given short texts with relevant information and pictures once a week. A 50-question multiple-choice exam was given prior to lectures, immediately after completing the 9-week course and 6 months after completion of the course. There was no statistically significant difference in

the two groups scores [12].

A larger study of 145 third-year medical students aimed to assess knowledge of skill versus medical knowledge using a microscope for urinalysis. The control group learned about microscopic urinalysis in a conventional script-based lesson, while the experimental group learned with an electronic adventure game. Both groups were given the same instructional contents before the activity. The outcome of a 34-question multiple-choice test found that game-based learning resulted in higher scores over traditional text-based or written instructions with 2.66 points or 7.8% higher scores in the game-based learning group [13].

Gamification

Gamification as a general pedagogical method is only mentioned in one randomized clinical trial. This trial enrolled 229 students who learned the same material from the same instructors, but the gamification group used methods like badges, ranks, levels, leader boards as part of the curriculum. This study aimed to assess learning behaviours including interest, effort, and motivation over time, but it did not assess any knowledge retention or knowledge outcomes. The students were divided into 2 main groups, one used gamification in the classroom and the other did not. The 2 main groups were then divided into 3 subgroups. The 3 subgroups were made up of different sized groups which included individuals, small groups of 5-7 students, and large groups of 20-25 students. The survey had questions that looked at various aspects that affect learning. The outcomes assessed student's interest, class effort, perceived competence, tension, comparison, discouragement, and motivation during the course. This study showed that gamification increased interest in individual and small groups but no improvement in interest in large groups. Similar findings were noted for effort and perceived competence. No change in the amount of comparison or discouragement was noted in any of the groups, but increased tension was noted in larger groups [14].

Discussion

Benefits of Gamification and Game-Based Learning

Most of the trials included learning behaviours and perceptions as a final survey. Some of the studies found that there was a statistically significant higher rate of motivation by the participants [4,5,9] confidence after the game-based learning [9,15] effort and interest [5] Satisfaction [4] interest and effort [5] also scored higher in the experimental groups. Interaction, participation, or engagement was also perceived to be higher when a type of game-based learning was used [3,6,9]. Although students did not have changes in outcome scores, their perception of learning the material and having the required knowledge after the activity increased when game-based learning or gamification was used in smaller groups [5,6,15]. Learning technical skills improved with the use of VR with no risk to patients when students make mistakes [13]. Clinical reasoning skills improved with the use of simulation by creating an interactive curriculum without any safety concerns [4,15].

Disadvantages of Gamification and Game-Based Learning

Whenever a new type of technology is introduced into a learning environment extra costs to the facility are incurred. The added cost may not provide enough cost-benefit ratio to justify the purchase. As technology advances, costs will decrease, and this may no longer be a disadvantage to some physician assistant programs. Navigation through some programs can be more complex, hindering the learning objective [2]. Gamification in larger groups has also been shown to discourage students from learning and participating [5]. Studies have also shown that competition can interfere with actual learning and that winning the game becomes the sole purpose of the activity instead of learning the material that is being taught [16].

Conclusion

Overall, bringing games into medical education has benefits. It is valued by the students and viewed as a positive experience by most. Disadvantages to students have been shown to be minimal. Increased costs may be prohibitive in some cases and the creation of the games may also be time consuming for faculty. Some faculty may also be hesitant to deter from traditional lecture style teaching.

Another limitation to the studies evaluated includes that some of them are self-reported studies where the students give their feedback by answering questions in surveys. Some students may be embarrassed to reveal their true feelings on the subject, or they may be afraid that the survey results may affect their grade in the class.

As it becomes more widely used, more studies need to be performed to determine if gamification has educational benefits and conveys long-term retention of information. The studies that are available have a small number of participants. Larger studies would be beneficial for proper evaluation of the benefits and drawbacks of gamification.

Conflict of Interest

The authors declare that they have no conflict of interest.

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