Original Article

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Website: www.jehp.net
DOI: 10.4103/jehp.jehp_624_20

Effectiveness of the game-based learning over traditional teaching–learning strategy to instruct pharmacology for Phase II medical students

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Abstract:

BACKGROUND: Game-based education is fast becoming an innovative teaching approach in the field of medical education. Traditional review sessions (tutorials) are mainly focused on instructor-based learning and they help to review concepts previously taught in the lecture class. The primary objective was to evaluate the cognitive learning of students in game based learning (GBL) as compared to the conventional review sessions. The secondary objectives were to assess the perception and feedback of students regarding GBL and conventional review sessions.

MATERIALS AND METHODS: An interventional GBL study was designed for 2nd year MBBS students. The enrolled students were randomly assigned to either tutorial (Group A) or GBL (Group B), and informed consent was obtained. Group B students were further divided into smaller groups, and for Group A, the traditional tutorial method was followed. For both the groups, a multiple choice question (MCQ) pre-test and post-test was conducted on the selected topics. A total of 15 MCQs with gradually increasing difficulty were used in the GBL. For each group of students, one student would be on hot seat by answering the questions and then continued the game. Lifelines were provided.

RESULTS: From the pretest and posttest scores, students performed better in Group B (39.53%) than Group A (18.43%) with respect to the knowledge score, and the difference was statistically significant. Students' perception and feedback regarding GBL were very enthusiastic and promising than the tutorial group. Largely, students commented that GBL was unique, active participation, fun, and novel learning style.

CONCLUSIONS: GBL is a student-centered learning and showed more effective than the traditional tutorials in understanding the topic and was more enjoyable by students.

Keywords:

Game-based learning, motivation, pharmacology, review session, student centered

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Received: 05-06-2020
Accepted: 02-10-2020
Published: 31-03-2021

Introduction

Educational gaming, in recent times, has gained peak attention as a technique to inspire students' learning by providing learner-centered atmospheres that provide experiential experiences, enhance learning, and stimulate interest and motivation for students to learn. An educational game is defined as an instructional method that requires the learner to participate in a competitive activity with the preset rules.[1] Electronic game-based learning GBL has a long tradition in medical education with the release of its first application in the 1960s and has gained much attention in recent years due to rapid technical advances in the computer and gaming industries.[2]

How to cite this article: Gudadappanavar AM, Benni JM, Javali SB. Effectiveness of the game-based learning over traditional teaching–learning strategy to instruct pharmacology for Phase II medical students. J Edu Health Promot 2021;10:91.

Traditional review sessions (tutorials) are mainly focused on instructor-based learning, provides a brief review of concepts taught in the lecture class.[3] Review sessions typically involve an overview of course materials followed by a period of questions and answers. Sometimes, the review sessions are less informative and uninteresting, simply a brief lecture on material previously covered, leading to little or no student participation and without any scope for a higher order of learning, i.e., critical thinking or application of the acquired knowledge.[4]

Medical educators' present challenge is to find new approaches to make learning more stimulating, motivating, and entertaining. The doyens in the field of medical education have formerly recommended teaching modalities that incorporate student-based active-learning strategies, also called learner-centered education.[5] The integration of games as a teaching tool is an innovative and challenging approach in the educational field.[6] Assimilation of digital educational games into existing medical education, i.e., GBL is a newly designed platform for medical students.[7,8] The modern technology of digital games can afford us the virtual experiences in a more cost-effective manner with provision to create and evaluate both positive and negative outcomes of the games.[9] These games include concepts and principles of adult learning; they encourage self-learning and greater participation in group learning activities along with enjoyment.[10] Consequently, by becoming actively involved in the learning process, the students' level of understanding and aptitude to integrate and synthesize material are enhanced.[11]

In addition, this technology provides a safe environment for learners to gain skills and self-confidence without harming patient's life, which otherwise might occur in everyday practice compromising the patients' safety.[12,13] A wide variety of studies and reviews in GBL in medicine are available for different application scenarios and user-groups. Often used games in medical education are quiz games.[14-17] These studies have recommended the positive effect of games on medical students' knowledge.[17-19] Previous studies have concluded that GBL encourages students to actively participate in the learning process, ability to integrate and synthesize material, promotes problem-solving skills and critical thinking.[4,7] Nevertheless, few authors have also stated that, due to the limited number of studies, their low-to-moderate methodological quality, and the inconsistent results, the evidence is less to support a general recommendation for the use of educational games in medical schools.[20]

Given this, an educational game "who wants to be a physician" was conducted in the pharmacology department for Phase II MBBS students based on the popular television game show "Who wants to be a millionaire." To determine if GBL can meet all our expectations, the present study was planned focusing on a single topic 'Drugs acting on Autonomic Nervous System (ANS)' during tutorial hours. It is an active learning exercise, because answering the questions requires knowledge of ANS as well as application of drugs influencing ANS. Hence, the purpose of this study was to preliminarily evaluate the attraction, motivation, and learning experience of the medical students toward GBL. Hence, this study was planned with the following objectives.

Objectives

- The primary objective was to evaluate the cognitive learning of students in GBL as compared to the traditional review sessions
- The secondary objectives were to assess the perception and feedback of students regarding GBL and conventional review sessions.

Materials and Methods

A quiz, testing the important pharmacological aspects of cholinergic and adrenergic system, was designed using the format of the international popular television game show "Who Wants to Be a Millionaire."[4,21] The game was designed for MBBS Phase II students having completed a section of 'Drugs acting on Autonomic Nervous System' of a pharmacology course through the didactic lectures. This game specially focused on "Drugs acting on ANS" For both the groups, identical four subtopics from ANS with the same learning outcomes were selected.

Ethical approval was obtained from the Institutional Ethical Committee (KAHER's JN Medical College, Belagavi, Ref: MDC/DOME/79 dated: 22/11/2017), and an interventional study was conducted over a period of 5 months (October 2017- February 2018) in the department of pharmacology. The MBBS Phase II students were orally informed about the nature of the study, in which a new instructional method was being evaluated and further informed that their participation was entirely voluntary, and the results will have no effect on their final results or grades. A total of 98 students were enrolled in the study and were randomly assigned to either a traditional teaching group, i.-e., control group (Group A, $n = 50$) or GBL, i.-e., experimental group (Group B, $n = 48$), and written informed consent from each student was obtained. For both the groups, a pretest and posttest was conducted, consisting of forty multiple-choice questions (MCQs) from the selected subtopics (ten questions from each subtopic) and correct answer carried "1" mark and wrong answer "0" marks. For the control group, the traditional method of tutorial was conducted by a tutor, and in the experimental

group, GBL was conducted. The GBL group was further divided into four small groups (12 students/group) randomly, and two facilitators played the role of the quizmaster to accomplish the quiz.

For the experimental group, a laptop and projector were used to conduct the study. A total of 15 MCQs of gradually increasing difficulty that are valid in terms of clinical practice and meet the desired learning outcomes were prepared for selected topic of ANS. All questions were provided with a short abbreviated answer that was often followed with a detailed explanation. For each group of students, one student earned the right to become the first contestant (took the "hot seat") by answering and explaining the answer to the group task correctly. Once on the hot seat, the contestant continued answering questions until he/she was unable to select and explain the correct answer to a question. They were then replaced with a new contestant, and the game started with the same sequence of question for the new contestant. When ambiguous, contestants had three lifelines (assistance) to help them obtain the correct answer. They were allowed to ask a friend in the group, ask the audience or whole group, or have two incorrect answers removed, narrowing their choice. These lifelines were available only once to each contestant. Rewards were given at various stages. To assess the knowledge gained by students, the scores of MCQ pretest and MCQ posttest of both groups were compared [Table 1]. On completion of the sessions, students' perception regarding the tutorials/GBL as an educational method was measured with a questionnaire consisting of 14 questions using a Likert scale [Table 2-questionnaire on perception]. In addition, a general comment section was included for any additional suggestions or comments. And also, feedback from both the groups was obtained to know the students' opinion of the overall usefulness of either pharmacology instructional method using a dichotomous questionnaire consisting of 14 questions (yes scored as "1" and no scored as "0") [Table 3- questionnaire on feedback].

The results were expressed as mean ± standard deviation. All the statistical analyses were carried out using SPSS software version 20.0 IBM corp. A comparison of within group was through paired't' test and between group was through independent sample 't' test. $P < 0.05$ was considered statistically significant.

Results

The scores of pretests and posttests followed a normal distribution. From this study, we observed that the cognitive learning outcome measured with the pretest and posttest scores, students performed better in Group B (39.53%) than Group A (18.43%), and the difference was statistically highly significant ($P < 0.001$***) [Table 1 and and Figure 1]. The perception of the students toward the learning experience was measured using a questionnaire on the 5-point Likert scale, and the score was higher in the GBL group ($P < 0.001$***) compared to the control group [Table 1 and Figure 2]. Group B students' perception was more encouraging; they enjoyed the game as it made the learning more interactive, collaborative learning environment and felt more confident. The Group A students' perception was little supportive about tutorials, had less enjoyment or enthusiasm, felt monotonous, were less confident, and had little active participation. Feedback of the students was taken using a questionnaire, scores of the experimental group were more encouraging ($p < 0.001$***), they felt unbiased, and sessions were very well organized than compared to the

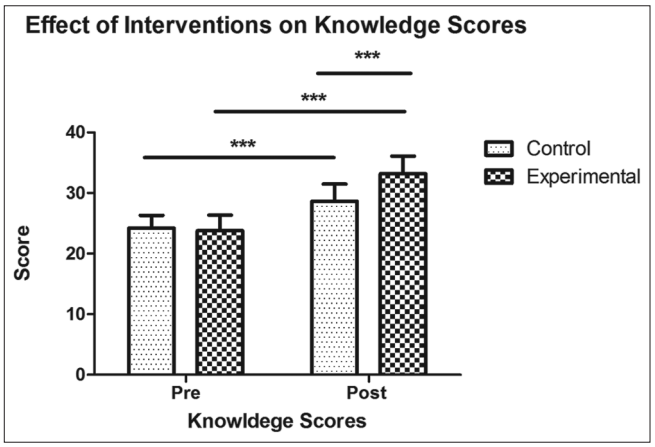

Figure 1: Effect of interventions on knowledge scores in control (Group A) and experimental group (Group B)

Table 1: Effect of interventions on knowledge, perception, and feedback scores in control (Group A) and experimental (Group B)

Parameters	Time	Mean±SD		$P^{\#}$
		Control (Group A)	Experimental (Group B)	
Knowledge score	Pretest	24.20±2.11	23.77±2.57	0.368
	Posttest	28.66±2.82	33.17±2.93	<0.001*
	$P^{@}$	<0.001*	<0.001*	
Perception scores	Posttest	34.48±6.77	62.12±6.07	<0.001*
Feedback scores	Posttest	6.04±1.38	13.25±1.37	<0.001*

[@]Paired *t*-test, [#]Independent *t*-test. SD=Standard deviation

Table 2: Questionnaire on students' perception about the tutorials/game-based learning in pharmacology

Item number	Items	5	4	3	2	1
1	The questions asked were relevant					
2	Instructions given were clear and adequate					
3	Time allocated was sufficient for each question					
4	Questions were consistent with the teaching objectives					
5	I enjoyed this session on ANS					
6	The session built on my previous learning in relation to ANS					
7	Exploring the topics in a collaborative environment with a group of colleagues was useful for learning					
8	The facilitator/tutor provided a learning environment, in which I felt confident to explore my understanding of ANS					
9	Personality, gender, and other attributes did not affect the scores					
10	Faculty were approachable					
11	Timely feedback was given					
12	The entire learning in the session was well coordinated and organized					
13	The learning session was free of confusing or conflicting concepts and mechanism.					
14	The use of hints/lifelines was helpful in answering the question					
15	Additional comments/suggestions					

Likert scale: 5=Strongly agree, 4=Agree, 3=Uncertain, 2=Disagree, 1=Strongly disagree. Tick: Group A/Group B. ANS=Autonomic nervous system

Table 3: Questionnaire on students' feedback regarding tutorials/game-based learning, as a teaching-learning educational method in pharmacology

Theme of student responses	Student response: Yes/no
Fun and enjoyable learning	
Opportunity to explore and explain answers/admit uncertainty	
Group learning, collaborative teamwork	
Feel confident at the end of the session	
Novel style of learning	
Relaxed and informal learning environment	
Building on/using PBL	
Novel/different approach to learning and testing knowledge	
There is a thematic organization of content to develop higher level thinking skills	
Interactive and supportive learning environment	
Covered wide knowledge area	
It provides a chance for the application of knowledge to clinical practice	
It is less stressful	
It should be continued in pharmacology as a method of education	

Tick: Group A/Group B. Scoring yes as "1" and no as "0" for data analysis. PBL=Problem-based learning

control group [Table 1 and Figure 2]. Students enjoyed the quiz sessions and helped them deeper understanding of the ANS. In general comments, most of the students' commented that GBL was unique, active involvement, less stressful, fun, and novel style of learning. Overall, the comments about the GBL were promising, and students would look forward to incorporate this method of teaching in their curriculum.

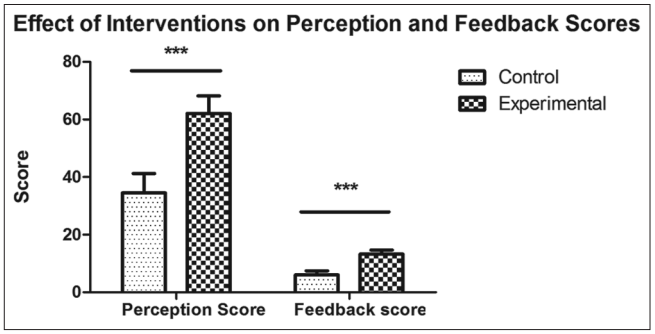

Figure 2: Effect of interventions on perception and feedback scores in control (Group A) and experimental group (Group B)

Discussion

In the present randomized control study, we compared the effectiveness of GBL to the traditional review sessions (tutorials), used to teach pharmacology for medical students, and also assessed the attitudes of students toward tutorials or GBL. This present study shows that students in the GBL group had a significantly higher cognitive learning outcome when compared with the students in the tutorial group. We believe that students in the GBL group had high enthusiasm, actively participating and probably had better retention, helped them to achieve better cognitive results in the posttest.

Furthermore the GBL group compared to the tutorial group had more fun, enjoyable learning and would like to learn more in this style. Students' comments were very enthusiastic and encouraging and also offered clear evidence for the beneficial effect of GBL on the students'knowledge and their attitudes toward their learning experience. Nevertheless, the long-term memory was not evaluated in our study.

Lifelines played an important role in the success of the game, involving more audiences actively. Lifelines kept everybody attentive since the audience could be called upon at any time and were rewarded. They were allowed to ask a friend in the group, ask the audience or whole group, or have two incorrect answers removed, narrowing their choice. These lifelines were designed to encourage the audience to answer questions when they were called upon for assistance by the contestant. Besides, by answering on their own, students could compare their answers with the contestant's response. In addition, the use of lifelines upholds the development of fundamental collective social interactive skills.[4]

Our study results were similar to a study done by Boeker *et.al*., proved that game-based e-learning is more effective, and had a high positive motivational impact on learning and performance of students. It also concluded that students had more fun, and would like to learn more in this style.[7] Another study concluded in their study that the game show helped medical students to learn in a relaxed and supportive learning environment.[18] Moy *et. al*. used an educational game to review the pulmonary physiology concepts in the 1st year medical students, and they found comparatively higher audience and participation of the students in the game, approximately one-half of the class enrollment, suggest a strong interest in this educational tool.[4] The students reported that they found the educational tool extremely useful, well presented, thorough in its content, and valuable in the mechanisms it reinforced from their prior course in pulmonary physiology.[4] In another study, the authors showed that the GBL method is comparable to the traditional learning method in general and in short-term gains, while the traditional lecture still seems to be more effective to improve students' short- and long-term knowledge retention.[14]

A 2010 systematic review of Akl *et. al*. on educational games found only five studies with low-to-moderate methodological quality eligible for the analysis.[20] Of these RCTs, three suggested a positive effect of the games on medical students' knowledge. However, the authors concluded that, due to the limited number of studies, their low-to-moderate methodological quality, and the inconsistent results, the evidence is less to support a general recommendation for the use of educational games in medical schools.[20] These games may be futile for learners who resist to process information or who do not enjoy playing games.[22] Other shortcomings may be as only a small percentage of the class participated, while the remaining students were the game's audience, thus sometimes failing to engage the entire class.[23]

Many previous studies stated that GBL encourages students to actively participate in the learning process, a role that promotes problem-solving skills and critical thinking.[4,7,20] By becoming actively involved in the learning process, the student's ability to integrate and synthesize material will be enhanced, and also student's knowledge to conceptualize systems and understand how they work will also be improved.[7,19] Ultimately, games absolutely suit millennials because games generate enthusiasm and stimulation throughout the educational process, as noted in the positive feedback from students as seen in our study and also previous study.[24] The main strength of games noted is that their ability to promote student-to-student interaction and peer learning and their excitement while playing.[25,26] In view of the advancement of the medical education technology and enthusiasm among millennial students, there is a call for designing computer-based educational games that will cater to the needs of new generation medical students. Conversely, limitations of this study were, long-term memory of students could have been evaluated, a large number of students were unable to involve in the game, as some of the students were the game's audience, thus sometimes failing to engage the entire class, and also teachers opinion about GBL could have been obtained with the purpose of adding in this student-centered learning method in their future curriculum.

Conclusions

GBL should be taken sincerely into account as an alternative instructional method on topics where student motivation might be a problem. Our objective in doing this study was to provide a fun, interactive, and innovative method of learning for students. The total posttest scores for all the four sessions were higher for the GBL group, indicating that GBL is more effective than conventional teaching during tutorials in understanding not only basics but also deeper aspects of the subject. GBL also showed that students had more fun, and would like to learn more with this concept of active learning. We would, therefore, recommend that GBL should be used to teach pharmacology, which involves active-learning strategies, student centered, an interactive learning environment to develop interpersonal, communication, and problem-solving skills.

Acknowledgment

The authors acknowledge the support of Dr. Nayana K. Hashilkar (Professor) and all other faculties and postgraduates of the department of Pharmacology, J N Medical College, Belagavi, in conduct of this study.

Financial support and sponsorship

Nil.

Conflicts of interest

There are no conflicts of interest.

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