

A Novel Approach in Understanding and Retaining the Subject Concepts among Medical Undergraduates using Treasure Hunt Competition as a Tool: A Quasi-experimental Study

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ABSTRACT

Introduction: There is a need to incorporate innovative teaching methods other than conventional didactic lectures to generate interest of medical undergraduates in learning Pharmacology. Game-based Learning (GBL) is a new strategy in medical education that can create a fun based atmosphere for learning.

Aim: To assess the effectiveness of GBL as a tool in learning process and in memory retention of the knowledge acquired in pharmacology using treasure hunt competition.

Materials and Methods: The quasi-experimental study was conducted on 4th semester MBBS students of Kanachur Institute of Medical Sciences, Mangaluru, Karnataka, India, from February to March 2019, as a part of the Advanced Course in Medical Education (ACME) project work, Medical Council of India. Entire phase II students (N=150) were included in the study. Students were divided into the GBL group and the Facilitated Learners (FL)

group. Both groups were exposed to their respective GBL and FL based learning. Before and after the respective GBL and FL sessions, a pretest and two post-test multiple choice questions based tests were conducted. The second post-test was conducted one month later as a surprise one. Thereafter, a questionnaire was given to pen down the perceptions about GBL. Pretest and post-test marks were analysed by one-way Analysis of Variance (ANOVA) followed by the Tukey-Kramer test. Perceptions about GBL were entered in percentage.

Results: The mean scores of the GBL group were significantly more (p-value <0.001) as compared to the FL group in both the post-tests. In their feedback about GBL, the students appreciated the usefulness of this innovative way of learning pharmacology.

Conclusion: The GBL is an effective tool to teach pharmacology to medical undergraduates.

Keywords: Innovative, Learning tool, Pharmacology, Team-based learning

INTRODUCTION

The subject pharmacology serves as a backbone in medical science curriculum as well as research based biomedical programs in higher education. It mainly deals with drugs and their interactions with living systems. A good grip over this subject is essential for any clinical practitioner. It is included as a para clinical subject in the medical course in India [1-2]. The most important purpose of teaching pharmacology is to facilitate undergraduate medical students to take logical therapeutic decisions in clinics. Teaching pharmacology to a second year medical undergraduate is a challenging task. The resemblance in drug names, their clinical uses, pharmacodynamic and adverse drug effect profile, always confuse the students and finally they forget the taught contents. Conventional lecture centered teaching emphasises more on theoretical aspects of drugs with less importance on their clinical application [3-5]. Recently for teaching pharmacology, small group discussions are included. This is done with a goal to increase student's active participation and to deal with clinical conditions, thereby enabling the students competent enough to solve clinical problems [5,6].

In the conventional pharmacology practicals, apart from prescription writing and clinical problems solving exercises, dispensing pharmacy exercises and experimental pharmacology topics are included to impart knowledge. However, relevance of these practical exercises in clinical utility is always been debated and criticised [5,7]. Students have pointed out in many questionnaire based studies that, even though pharmacology is an essential part of the medical curriculum,

the subject is boring and volatile. The basis of this perception could be the vast nature of the subject and difficulty in memorising the details of many drugs at a stretch [6-10]. Even though, attempts are made all over India to make the training in pharmacology more exciting and relevant with the impartation of competency based medical education, it is hard to mend student's perception about traditional methods in pharmacology teaching [5,11,12].

Failure to converge knowledge and skill by an effective method made this basic science subject less appealing and tough for most of the medical undergraduate students. It is high time for the pharmacology faculties to change their perception that subject pharmacology is a dull one. Faculty should keep in mind the learning can be an effective, long-lasting experience if it is driven by fun-loving approaches and worth memorising experiences [13].

In the present scenario, teaching trends in medical education also exhibit some form of a shift from the conventional classroom teaching methods to incorporating unconventional teaching methods. A bit of creativity and unconventional thinking is needed to produce this interest [2-4,13].

It's heartening to see that many pharmacology faculties in India have tried diverse teaching-learning methods to generate interest in students on this volatile, boring subject. A number of innovations such as crossword puzzles, jigsaw active learning, E-learning modules, drug models, prelecture assignments, poetry, Case Based Learning (CBL), role-plays, seminars, simulations are tried as

an adjuvant to conventional teaching methods to arouse interest in the subject and for knowledge retention [1,4,5,12-17].

The concept of conducting treasure hunt competition in understanding and retaining the concepts of pharmacology is novel. It is a part of Game-based Learning (GBL). Games offer a wide opportunity to complement traditional teaching methods and infuse teaching with vigour, ignite innovative thinking and offer diversity in teaching methods. Through GBL, learners are prompted to combine knowledge and skills from different areas for a solution. They can observe the outcome of the game, based on their judgment and actions. Plus they are forced to get in touch with other team members, converse and adjust the steps in finding an answer, thus recuperating their social skills. Psychologists have proposed that GBL could help children to master cognitive skills and expand their imagination. In a safe learning environment without the distractions of a complex clinical setting, game-based learning offers many advantages as it nurtures better and more effective understanding which in turn helps to retain information for a long time. GBL is extensively utilised in various fields such as the military, education, marketing and advertising [5,11,18-24].

Considering all the above facts, this study was done to explore the effectiveness of GBL as a tool in learning process and in memory retention of the knowledge acquired in pharmacology using treasure hunt competition.

MATERIALS AND METHODS

The quasi-experimental study was conducted on 4th semester MBBS students of Kanachur Institute of Medical Sciences, Mangaluru Karnataka, India, February to March 2019, as a part of the Advanced Course in Medical Education (ACME) project work, Medical Council of India. The entire 4th semester MBBS students (N=150) were enrolled for the study, after obtaining Institutional Ethics Committee Clearance (2/FEB/IEC/2019; dated 13th February 2019). Informed consent was obtained from participants.

Inclusion and Exclusion criteria: All the 4th semester MBBS students who were willing to take part in the study were included and students who quit before the completion of the study were excluded from the study.

Study Procedure

They were not compelled or forced to take part in the study. Even though, the students were informed that taking part in the study was not compulsory and they were free to quit the study at any point of time, all 150 students willingly joined the study and took part in all the sessions. In brief, the study was done as follows

1. After theory topics on a particular system were taken, Multiple-Choice Questions (MCQs) test of five marks, i.e. pre game test, was conducted.
2. Treasure hunt competition was organised after the test.
3. For conducting the treasure hunt competition, students were divided into small groups comprising of less than ten. Each group was assigned a group captain. There were different stations for this game. In each station, a set of questions/clinical problem/chart was kept. An answer to each station was a part of the clue, where the treasure is kept. The main attraction of this game was that participants could refer to standard medical textbooks in pharmacology for solving the questions in a stipulated time of one hour. The group captain reported to the game co-ordinator about the clue his/her group had solved, enabling them to locate the hidden treasure. When a wrong clue was reported, the game co-ordinator conveyed to the group members of the particular group members to search for the correct one. The group which solved all the clues first were able to find the hidden treasure. Irrespective of a group winning the treasure, the other groups were also asked to solve the clues.

4. After the game was played, another MCQ test of five marks (GBL postgame test 1) was conducted on the same topic. Moderate to tough questions were asked.
5. Exactly after a month, a surprise MCQ test of five marks (GBL post-game test 2) was conducted on the same topic. Moderate to tough questions were asked.
6. After GBL post-game test 2, students were given a peer validated questionnaire to pen their perceptions about GBL. The questionnaire was prepared by referring to published articles of studies on other teaching-learning methods like computer-based learning and team-based learning. Further, the prepared questionnaire was validated by peers within and outside the institute. This was approved by the scientific and Ethics Committee of the institute. Students were given a time of 15-20 minutes to pen their perceptions about GBL.
7. Altogether, three treasure hunt competitions were conducted during the February 2019 to March 2019 study to validate the efficacy of game-based learning. In the first GBL, entire students, i.e., all 150 students, were exposed to a treasure (topic-cardiovascular system). Pretest and post-test 1 and 2 were conducted. In the second and third GBL, 150 students were divided into two groups:

- Total 75 were exposed to GBL, and
- The rest 75 were exposed to Facilitated Learning (FL).

During the one hour period of facilitated learning, the first 15 minutes were utilised to summarise the important points in the particular topic by the faculty and for the rest of 45 minutes, students were asked to read the textbooks. They were encouraged to ask to clarify doubts with faculty whenever required. In short, this facilitated learning is a modified way of conventional lecture. Pretest, post-test 1 and 2 were done like that in GBL-1 for both the groups. This facilitated learners group was added as per the recommendations suggested by the institutional ethics committee.

8. The total marks for each MCQs were five. It was taken care that the participants who were not exposed to treasure hunt in GBL-2 were given a chance in GBL-3.

Treasure hunt design: A brief word about how this game was played.

In this game, a treasure (chocolate) was kept near ROTAROD apparatus. The clue about it was gained after solving all the questions/charts kept at various stations. For example answer of question 1 was a drug name starting with letter R, for other questions the drug name started as follows

S2: O

S3: T

S4: A

S5: R

S6: O

S7: D

That is, when they solved all questions at various stations and when they combined the first letters of all answers it was read as ROTAROD, name of an apparatus which is kept in the experimental pharmacology lab. The participants were informed initially that the first letters of the solved answers will lead to a clue where treasure is hidden. That means treasure is near ROTAROD apparatus. Solving the questions was done by referring standard text books in pharmacology.

The above clue was kept for one of the treasure hunt competition. Different clues were kept for other treasure hunt competitions. After the treasure hunt competitions and subsequent tests were conducted, a feedback was collected from the participants to know their perceptions and opinion about GBL.

STATISTICAL ANALYSIS

All the data procured from the study i.e. pre test and post test marks are expressed as mean±standard deviation, they are analysed by one-way Analysis of Variance (ANOVA) followed by Tukey-Kramer test. The p-value<0.05 was considered significant. Analysis was carried out using Graphpad Prism software. The questionnaires were scrutinised and student's perceptions about GBL are depicted in percentage.

RESULTS

GBL helped students in conceptualising and memorising a topic from the cardiovascular system: From [Table/Fig-1], it is clear that students' performance after undergoing GBL has significantly ($p<0.001$) improved compared with their pre game test marks. It is also noted that their knowledge retention was significantly high ($p<0.001$) after undergoing GBL, as evidenced by their post game test-2 score.

Group	Marks scored out of five in 1 st test	
I	GBL pretest	1.273±0.834
II	GBL post-test-1	2.84±1.01 ^a
III	GBL post-test-2	3.07±1.19 ^{a,b}

[Table/Fig-1]: Marks scored before and after GBL-1, topic: Cardiovascular System (CVS).

N=150, values are expressed as mean±standard deviation.

Analysis: One way ANOVA followed by Tukey-Kramer.

Software: Graph pad prism

a: p-value <0.001, considered extremely significant on comparing group II, III with group I

b: p-value=0.452 considered not significant on comparing group III with group II

GBL: Game-based learning

GBL is effective than FL in conceptualising and memorising the topics in Pharmacology: From [Table/Fig-2,3], it is clear that students performances after undergoing GBL in two topics of pharmacology (GIT and autacoids) have significantly ($p<0.001$) improved on comparing with their pre-GBL test marks. It is also noted that their knowledge retention was significantly high ($p<0.001$) after undergoing GBL, as evidenced by their post GBL test-2 score, compared with pre GBL test marks. It is interesting to see that post GBL test-1 scores were significantly higher ($p<0.05$) than post FL test-1 scores in the topic of autacoids. Another important thing observed was that the post FL test-2 marks were considerably reduced ($p<0.01$) compared with the post-FL test-1 score in the topic of autacoids. It is noteworthy to mention that the post GBL test-2 scores were extremely ($p<0.001$) higher than the post FL test-2 scores in both the topics of GIT and autacoids.

Perceptions and opinions about GBL: Questionnaire results and the student's perceptions clearly showed that more than 90% of the participants liked this new way of teaching in pharmacology [Table/Fig-4].

Group	Marks scored out of five in 2 nd test GIT	
I	GBL pretest	1.37±0.8
II	GBL post-test-1	3.3±0.78 ^{a,b,f}
III	GBL post-test-2	3.61±0.71 ^{a,g}
IV	FL pretest	1.37±0.91 ^c
V	FL post-test-1	2.92±0.78 ^{d,e}
VI	FL post-test-2	2.42±0.64 ^d

[Table/Fig-2]: Marks scored before and after GBL-2 and FL-1, topic-Gastrointestinal Tract (GIT).

N=75, values are expressed as mean±standard deviation.

Analysis: One way ANOVA followed by Tukey-Kramer.

Software: Graph pad prism

a: p-value <0.001, considered significant on comparing group II, III with group I

b: p-value=0.639 considered not significant on comparing group II with group III

c: p-value=0.158 considered not significant on comparing group IV with group I

d: p-value <0.001, considered extremely significant on comparing group V, VI with group IV

e: p-value=0.076, considered not significant on comparing group V with group VI

f: p-value=0.269, considered not significant on comparing group II with group V

g: p-value <0.001, considered significant on comparing group III with group VI

GBL: Game-based learning; FL: Facilitated learning

Group	Marks scored out of five in 3 rd test	
I	GBL pretest	1.26±0.75
II	GBL post-test 1	3.42±0.8 ^{a,b,f}
III	GBL post-test 2	3.62±0.74 ^{a,g}
IV	FL pretest	1.18±0.74 ^c
V	FL post-test 1	2.81±0.8 ^{d,e}
VI	FL post-test 2	2.16±0.63 ^d

[Table/Fig-3]: Marks scored before and after GBL-3 and FL-2, topic: Autacoids.

N=75, values are expressed as mean±standard deviation.

Analysis: One way ANOVA followed by Tukey Kramer.

Software: Graph pad prism

a: p-value <0.001, considered significant on comparing group II, III with group I

b: p-value=0.951 considered not significant on comparing group II with group III

c: p-value=1, considered not significant on comparing group IV with group I

d: p-value <0.001, considered significant on comparing group V, VI with group IV

e: p-value=0.009, considered significant on comparing group V with group VI

f: p-value=0.027, considered significant on comparing group II with group V

g: p-value <0.001, considered extremely significant on comparing group III with group VI

GBL: Game-based learning; FL: Facilitated learning

Question	Agree	Disagree	No opinion
	Number (%)	Number (%)	Number (%)
Game-based Learning (GBL) is more enjoyable	138 (92%)	3 (2%)	9 (6%)
GBL is easy to perform	127 (84.6%)	11 (7.33%)	12 (8%)
GBL contributes more to understanding theoretical concepts	136 (90.66%)	4 (2.66%)	10 (6.66%)
GBL is time consumable	13 (8.66%)	127(84.6%)	10 (6.66%)
GBL should be conducted as an adjuvant to theory classes	135 (90%)	8 (5.33%)	7 (4.66%)
GBL helps in memorising the pharmacological concepts	133 (88.66%)	7 (4.66%)	10 (6.66%)
GBL is helpful on long run	141 (94%)	3 (2%)	6 (4%)

[Table/Fig-4]: Perceptions and opinions about GBL.

Other important points mentioned by students:

"GBL contributes more to understand theoretical concepts and memorising the topics"

"Interesting and help to gain knowledge"

"I was motivated to read text books like K D Tripathi"

"GBL is fun based learning, obviously add to long run memory"

"GBL should be conducted more often"

"GBL helps to cover more topics in a very short time"

DISCUSSION

Pharmacology, like any other branch of medicine, is evolving year by year. Usually, in India, the pharmacology teaching in medical colleges depends on a lecture-based approach. This type of teaching is not an effective method in prompting higher order thinking. As a result, the knowledge of basic pharmacology is less among medical practitioners and students consider it to be a very complex, volatile and dry subject with minimal relevance. Restructuring in undergraduate teaching must be made regularly to improve the standard of teaching. Reassessing the teaching methods periodically and modifications in the various methodologies in teaching schedule is a must to match up with the global standard of teaching. Therefore, to accomplish both the learning demands and National Medical Commission (NMC)'s requirements, new strategies are necessitated in Competency Based Medical Education (CBME) based pharmacology teaching [7,8].

It is a fact lectures will remain as the essential part of teaching methodology for next few years as they are a part of curriculum in India. There is a need for innovative teaching methods to adjuvant the usefulness of lectures and at the same time make the learning more interesting and stress free [8,9,12].

Game-based learning is an innovative tool in teaching method to impart knowledge in the field of pharmacology. So, a game-based learning was conducted in topics from cardiovascular system, gastrointestinal system and autacoids. These topics were selected based on student's request.

The reported use of games in pharmacology teaching is uncommon. The slow implementation of games in pharmacology teaching may be because of ambiguity and confusion of how games could have a role in medical education and how they can do well to both students and educators [15,21,23].

In this study, the majority of students opined that the GBL to be fun and motivating. From the results it was observed that students who were exposed to GBL excelled in both the post game tests, when compared with the students who underwent facilitated learning. It is to be noted that both types of learning were done after the didactic lecture on the particular topic was delivered. The most important point to mention is GBL students were able to recollect more points during the surprise post test-2 sessions on comparing with FL students. Even though, both the teaching methods were done in a stress free, friendly environment, the major reason for the improved performance and improved retention of knowledge by GBL students can be because of two key factors motivation and enthusiasm. These factors were missing in facilitated learning sessions.

Similar with other studies, where different games like jigsaw puzzles, cross word puzzles, quizzes were utilised to improve learning in medical undergraduates [7,8,12,13,15,17]. The present study using treasure hunt as a tool to impart knowledge and retaining memory in pharmacology was also found effective.

With these game-based sessions in the present study, the students were able to observe directly how their learning and judgment skills can be applied to solve the problems in front of them for getting the clue of place where treasure is hidden. This made the sessions exciting, interactive and enthusiastic. Above all they were motivated to read textbooks and grab the knowledge in a quick span of time to beat their peers in other treasure hunting groups. The internal motivation and enthusiasm for learning is proved to have a positive influence on the learning process all through the medical career of a student [8,21].

The students reported that GBL enhanced their ability to understand the concepts and incorporate the knowledge in an effective manner, that too in a fixed time period. Furthermore, GBL also helped in applying the knowledge in these topics, as was evident from the higher test scores in post game sessions as compared to the test scores in facilitated lecture-based sessions. During the study, students were actively interacting with their peers while playing to find the correct clue for the hidden treasure. In other words, GBL promoted Team-based Learning (TBL).

Team based learning is a novel and effective strategy of teaching methods that encourages peer interaction and self directed learning [4]. Team-based interaction and learning skills are necessary for a good health care delivery in the future. Education experts emphasise that students gain more knowledge through discussions with instructors and other classmates [19,23].

Games and gaming elements create fun and enthusiasm in stressful environments. Well planned games are cognitively challenging. They make learners occupied and aid progression through difficult tasks. The tasks in a well structured game engage learners in diverse aspects of serious play, such as planning, interacting, decision making, proof gathering, competing, reviewing feedback and self improving [19,20,25].

Game-based learning can be useful as an adjuvant option to classroom lecturing. Games can provide the motivation to learn, increasing the probability that the required learning outcomes can be attained [18].

Game-based learning is a tool which makes use of the game as a medium for learning. The success of GBL techniques is obliged to energetic participation and communication. GBL is a trending topic amongst human resource and education fields internationally. The game and its game plan are enabling the students to master the concepts. Through, a game, a player can increase the skills, ability, and art of applying knowledge when required. Through GBL, we can not only generate an outlook that push students to go for new things, but also an environment where the student is no longer worried of failing [20].

The more pleasurable an educational game is, the more actively students will continue in playing it. However, the teacher must make sure that educational information is not mislaid in the enthusiasm and competition of the game. Further, the complexity level of the game should be modest as complex games dispirit students from participating. To be successful, the educational game needs to strike equilibrium between instructive contents and gaming rudiments. It is feasible to develop educational games, without much funding and sophisticated technological expertise [21,23].

To summarise, this study shows that a properly planned educational game can successfully engage pharmacology students with greater motivation and enthusiasm, and it can be developed as an offline or online based module to support classroom teaching in the blended learning approach.

Limitation(s)

Even though, there was no difficulty in getting the students enrolled for the study as entire batch was keen to participate in the study, one of the drawbacks of GBL was, not all students wished to gain knowledge by this method. It was echoed in their feedback. From the faculty's perspective, for planning a GBL an extensive time has to be invested. More over once used, the game material (clues) cannot be reused. For every game new clues and new places to hide treasure has to be ensured. This is likely to be a tedious one, when GBL has to be conducted frequently. The MCQ tests conducted before and after the respective learning sessions were only of five marks. The effectiveness of this treasure hunt based teaching has to be proved by conducting MCQ tests of more marks or by conducting essay based questions. Further, the effectiveness of this game-based learning has to be proved by conducting it in other medical institutes.

CONCLUSION(S)

In conclusion, any game-based learning can be a great tool to boost the effectiveness of conventional lecture-based sessions in pharmacology by creating an atmosphere of fun, enthusiasm and motivation.

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