

RESEARCH ARTICLE

Effectiveness of computer-assisted learning as a teaching method in experimental pharmacology

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ABSTRACT

Background: Recently, there has been a progressive reduction in the use of animals for teaching purpose due to ethical consideration. Computer-assisted learning (CAL) is one of the non-animal alternatives in experimental pharmacology to simulate the live experiment using animals. Although it offers benefits of being reproducible, time saving, and having minimum errors, it has its own drawbacks. **Aims and Objectives:** The present study is undertaken to study the effectiveness of CAL by comparing demonstration method using live animals and CAL method among 2nd year MBBS students. **Materials and Methods:** A total of 71 students participated in the study. They were given a set of multiple-choice questions (MCQs) on a selected topic (effect of diazepam on mice using Rotarod apparatus) after demonstration of experiment using animals. Later, CAL was performed by all the students followed by the same set of MCQs. A student feedback questionnaire based on the 5-point Likert scale was also given to all the students to get their opinion about the simulation experiments. **Results:** The students had a better average score in CAL method as compared to the method using animals (82.4% vs. 44.6%). Based on feedback, majority of students (70%) agreed in favor of CAL. **Conclusion:** The effectiveness of CAL in teaching experimental pharmacology has been demonstrated and students agreed that CAL assisted them in understanding the topic better as the effects were visualized on the screen clearly. Thereby, such simulations should be considered as an essential component of the standard curriculum.


KEY WORDS: Computer-assisted Learning; Experimental Pharmacology; Feedback Questionnaire; Medical Students

INTRODUCTION

Over the recent years, there has been a progressive decline in the animal usage for teaching purpose in experimental pharmacology due to the ethical considerations. It is felt that animals should not be sacrificed just to obtain skills and experimentation techniques as there is a scarcity in the availability of animals. Hence, the guidelines put forth by

the Committee for the Purpose of Control and Supervision of Experiments on Animals, the Medical Council of India, and University Grants Commission suggest 3 R's, i.e., replacement, refinement, and reduction in animal experiments. Rehabilitation, the fourth R, was added recently as an additional measure for their care.^[1,2] Undergraduate training in pharmacology has been reformed with the development of several innovative teaching methods such as small group discussions, role plays, computer-assisted learning (CAL), and use of audiovisual aids.^[2]

CAL is one of the non-animal alternatives in experimental pharmacology to simulate the live experiment using animals. It offers the benefits of being reproducible, time-saving, and having minimum errors.^[2,3] Moreover, the practical sessions in pharmacology involving animal experiments are

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considered unnecessary as the objectives of these practical sessions primarily focused on observational, analytical, and interpretative skills.^[2]

CAL is a group learning skill used offline or online relating interaction of the student with programmed instructional materials. This integrated multimedia software performs as animal simulators that closely mimic reality. CAL is a software obtained from Elsevier, and this animal simulator is an encouraging alternative. In the period of rapidly shifting trends in teaching methods, CAL comes as a package with both advantages and disadvantages.^[2,4,5]

Observing the effects repetitively without the usage of animals, clear visualization of effects on the screen and less time consumption are some of the advantages of CAL. On the other hand, CAL also has various disadvantages such as it is programmed with prefixed dose, and hence, students cannot appreciate the response with varying range of doses. There would not be any interaction with live animals, and hence, practical knowledge about the experiment will be poor.^[4,5]

Efforts have been made all over India to make the teaching of experimental pharmacology more interesting and pertinent. Assessment tools like feedback questionnaire may assist to distinguish about the pros and cons of teaching and assessment methods. At present, student's feedback represents the most important means, and it is used by most programs to evaluate their methodology.^[5,6]

To explore these aspects from student's perspective, this study was planned to collect their view on CAL usage as an alternative to animal experiment.^[2,7] The present study was conducted to study the effectiveness of CAL by comparing CAL method and method using live animals among the 2nd year M.B.B.S students. Further evaluation was performed using the feedback of CAL session among them using a pre-validated questionnaire at the end of the study.

MATERIALS AND METHODS

A cross-sectional questionnaire-based observational study was conducted in March – April 2018 among 71 medical students. A total of 71 students participated in the study. Before the conduct of the study, the students were given a brief information about the purpose and process of the study. The questionnaire forms were distributed among the students after taking an informed consent from all the students.^[3,8] The ethics committee approval was obtained before the start of the study.

The students were given a set of multiple-choice questions (MCQs) on a selected topic (effect of diazepam on mice using Rotarod apparatus) after demonstration of the experiment using live animals. Later, CAL was demonstrated and was performed by all the students followed by the same set of

MCQs. At the end of the experiment, a pre-validated, student feedback questionnaire based on 5-point likert scale which is an anonymous questionnaire was also given to all the students to get their opinion about the simulation experiments.^[3,5,8]

Statistical Analysis

Evaluation of MCQs after CAL and experiment using animals was done by manual scoring. The data obtained from the student feedback form were compiled and analyzed manually by frequency analysis.

RESULT

It was observed that mean score and percentage score increased after the CAL experiment (8.24; 82.40%) compared to the other method using live animals (4.46; 44.60%) [Figure 1]. The results from the feedback forms indicated that the students could visualize the effect of drugs on computer screen clearly (83.09%) which led to an understanding of the topic in a better way (91.54%).

About 42% of students felt that technicality of CAL software could be a challenge if it is incorporated in routine teaching. However, most of the students (85.91%) accepted CAL method as teaching method and felt that CAL should be used for MBBS course as a part of regular experimental pharmacology teaching [Table 1].

DISCUSSION

Here, a questionnaire-based comparison was done between both methods for medical undergraduates to study the effectiveness of CAL. In this study, we also evaluated the feedback of CAL at the end of the session. It has been noted that, unlike animal experiments, CAL is considerably better in many aspects as far as the undergraduate teaching is concerned. Faculty in pharmacology has been introducing teaching methods with many integrated teaching approaches to make the subject

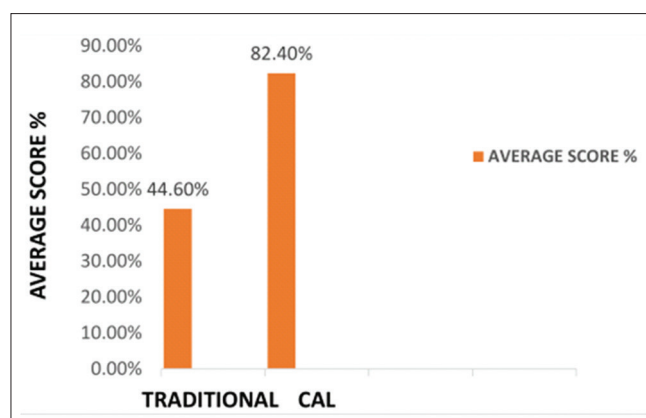


Figure 1: Average score percentage of traditional versus computer-assisted learning methods

Table 1: Student's response on their perception and experience of CAL

Q. No.	Questions	Response, n (%)				
		SA	A	ND	D	SD
1.	Computer simulation technique gives a better understanding of the topic than traditional method of teaching	41 (58)	24 (34)	1 (1.4)	4 (5.6)	1 (1.4)
2.	Effects of drugs can be clearly visualized by computer simulation	9 (13)	50 (70.4)	1 (1.4)	6 (8.4)	5 (7)
3.	Errors in experiments can be reduced by computer simulation	16 (23)	41 (58)	7 (10)	5 (7)	2 (3)
4.	Computer simulation are time saving than the actual experiments	16 (23)	32 (45)	9 (13)	3 (4.2)	11 (15.4)
5.	This method has a disadvantage of computer expertise being required to perform these experiments	12 (17)	37 (52)	9 (13)	7 (10)	6 (8.4)
6.	CAL requires resources and is an expensive method	15 (21.2)	40 (56.3)	4 (6)	8 (11.2)	4 (6)
7.	CAL is more interesting than the traditional method	12 (17)	42 (59.1)	6 (8.4)	7 (10)	4 (6)
8.	If given a chance, I would like to perform the actual experiment with the live animal rather than a computer simulation	12 (17)	37 (52.1)	17 (24)	3 (4.2)	2 (3)
9.	I think that CAL techniques should be incorporated in other pharmacology experiments also wherever possible	6 (8.4)	40 (56.3)	12 (17)	8 (11.26)	5 (7)
10.	I am accepting CAL method as teaching method and should be utilized for MRBS course	12 (17)	43 (61)	4 (6)	5 (7)	7 (10)

SA: Strongly agree, A: Agree. ND: No difference. D: Disagree, SD: Strongly disagree, CAL: Computer-assisted learning

more interesting. One such approach is the CAL experiment as it helps the students to understand the subject better than by attaining their learning outcomes. CAL also assists the students to learn at their own pace. During the experiment, a student can pause, resume, and repeat the steps for learning the responses to a particular drug which is always an advantage for slow learners as well as researchers.^[4] Both advantages and disadvantages were observed during the course of the study.

The role of advanced teaching tools such as CAL seems encouraging in better understanding of the subject as it is obvious from the improvement in scores of the students in CAL test (82.40%) from an experiment using live animal test score (44.60%). Similar improvements in student perception and performance after CAL have also been observed in the following studies. Tikoo *et al.*^[3] who studied "Student's perception and experience of CAL as a teaching method in experimental pharmacology" concluded that students felt that this method helped them in better understanding of the topic with the post-CAL score 82.50% and pre-CAL score 32.70%. Another study by Nettah^[9] who evaluated CAL as a teaching-learning method in experimental pharmacology also showed a significant improvement in post-test score (80%) as compared to pre-test score (67.7%). Gaikwad and Tankhiwale^[10] conducted a pilot study on the topic "Interactive E-learning module in pharmacology" and came out with the result that the average test score increased significantly from 38.42% (pre-test) to 66.46% (post-test). In our study, the medical students (92%) agreed that they could perceive the concepts better through CAL and 81% of the students agreed that chances of error in performance were less with CAL. 68% of them opined that CAL is more

time saving than the actual experiments which covered the topic in 2 h. They felt that if the software was provided to them as part of their curriculum, they can study as well as practice various experiments as many times as possible. However, in Sharma *et al.*^[7] study, a comparison between CAL and practical animal experiment observed only 25% of the medical UG students agreed that CAL method imparted a better understanding of the subject compared to practical animal experiment. However, 100% of the students agreed that CAL is quicker, time-independent method and repetition is possible with CAL. In the study conducted by Nettah,^[9] conclusion was made that it took only 2 h per student to understand the whole topic using CAL. This has also been observed in the study by Kamath^[11] who did a research on the use of eLearning in pharmacology. The author concluded that advantages of CAL are that the students can go through the learning content over and over again, thereby attaining more clarity on the content. Learning content can be delivered easily and less time consuming, can be reused, and can also deliver clear visuals of drug mechanisms and interactions on the screen. Another study by Brain *et al.*^[12] titled "Evaluation of the usefulness of a computer-based learning program to support student learning in pharmacology" suggested that the majority of students (>80%) found the program easy to use and enabled them to manage their own learning. Fletcher *et al.*^[13] also claimed that CAL reduced 31% of the time required by the students to do the experiment compared to the method using live animals. Tikoo *et al.*^[3] also came out with the same results that 94.5% of students suggested that computer simulations offer a better understanding of the topic. 83% agreed that CAL involves minimization of errors during the experiment. 93% felt that drug effects can be

clearly visualized and 95% opined that it consumes less time. Most of the students (76%) felt that CAL is more interesting than the method using live animals and hence should be incorporated in other pharmacology experiments as with blackboard teaching. 78% of the students accepted CAL method as teaching method and emphasized that it should be utilized for MBBS course. Hughes^[14] also did a research whether computer simulations of laboratory practicals really met learning needs or not. In the results, the author stated that CAL is the best suitable alternative to practical laboratory classes and successfully meets the learning objectives of the sessions. Another study by Tikoo *et al.*^[3] came out with the discussion that 97% of students opined that CAL is an interesting method and can be combined with other pharmacological experiments and it can also be recognized as a teaching method. In another study by Sharma *et al.*,^[7] 100% of the medical UG students agreed that CAL is an interesting method. Nettah^[9] also studied that CAL software can be used as a standard method for teaching experimental pharmacology to students. John *et al.*,^[15] in his study titled “A review of CAL in medical undergraduates,” found other benefits with CAL which were not studied in the present study. The benefits were a reduction in biological variations, availability of the experiments to the students at any time, and no cost in animal procurement, and the results are reproducible. Another study by Baby *et al.*,^[16] “CAL: A modern tool for Pharmacology,” also narrates other advantages that current computers with audiovisual aid capabilities can provide such as interactive and personalized learning experience and thus encourage self-directed learning.

Coming to demerits of CAL, the technical knowledge of computers should be good among students as well as faculty. Many students (69%) agreed that computer expertise is a must in performing these experiments. Sharma *et al.*^[7] also emphasized that many teachers are not well versed with recently developed software and need technical help in these areas. Although the errors in experiments can be reduced by CAL, software errors seem to be the major issue. This is studied in Nettah^[9] who suggested that technical problems arising during class and dependence on computers are likely the drawback of this method. In the study conducted by Tikoo *et al.*,^[3] many students (60%) did not agree that computer expertise can be an interference in such experiments which may be due to their prior exposure to the computers at the school level. In the study, perceptions and knowledge skills of UG medical students through CAL conducted by Govindaraja *et al.*^[4] also pointed out that one of the disadvantages of CAL is in the technical knowledge of computers and software. In our study, we found that CAL is an expensive method compared to the cost of purchasing animals which was agreed by almost 78% of students. Greenhalgh^[17] suggested that the cost of software charges often prove a more important limitation in accessing web-based materials. In the study conducted by Tikoo *et al.*,^[3] the author highlighted that these software presently are expensive, and the high start-up cost of their

installation in an institution is a huge limitation. However, Nettah^[9] in his study titled “CAL as a teaching learning method in teaching experiment pharmacology” observed that there was a reduction in expenses involved for animal experiments which they opined to be a definitive advantage of this method.

Limitations of the Study

In our study, most of the students felt that, they would like to perform the experiment with the live animals rather than a computer simulation method because simulated experiments lacked direct interaction with the living tissue, and since the doses were prefixed, they could not appreciate the biological responses at their desired doses. Second, CAL may be simply forgotten in contrast to animal experiments since practical knowledge and experience are lacking. The sample size was small, and the study was conducted one in single batch students. The authors only demonstrated the traditional method; however, allowing the students to perform traditional methods with live animals would have been more beneficial.

CONCLUSION

Our study shows the effectiveness of CAL in experimental pharmacology teaching, and students felt that CAL assisted them in a better understanding of the topic as the effects were visualized on the screen clearly. Thereby, such simulations need to be a part of the standard curriculum in the future for undergraduates. Proper training and resources should be given to both the teachers and students so that standards of conventional teaching methodology will be enhanced. CAL also affords a unique learning experience among students, widening the prospects of learning in pharmacology. Thus, to conclude, the use of CAL as an alternative to traditional animal experimentation is becoming progressively an interesting area among undergraduate practical teaching in experimental pharmacology. It is also a welcoming change for the students.

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