Is There Any Benefit of Integrating Computer-assisted Learning with Conventional Teaching Format in Pharmacology to Demonstrate the Effects of Different Drugs on Mean Arterial Blood Pressure in an Anesthetized Dog?: A Comparative Study

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Abstract

Purpose: Computer-assisted learning (CAL) tools are often used in medical education as it can complement conventional teaching formats and as an alternative to animal experiments in undergraduate medical students. To identify if there is any benefit of integrating CAL tools with conventional teaching format in pharmacology for a specific topic. **Materials and Methods:** Two groups of fourth semester students, Group I ($n = 55$) and Group II ($n = 60$), were taught a specific topic in pharmacology using only conventional teaching format (Group I), and both conventional teaching format as well as CAL format (EP Dog version 1.1.0) (Group II). The students were assessed with two different sets of multiple-choice questions, relevant to the topic taught, immediately at the end of the teaching sessions and after 30 days. Acceptability of the two teaching sessions by the students was also assessed using Likert scale. **Results:** There was no significant difference in the scores of the students of the two groups immediately after teaching ($P = 0.1260$), there is definitely better residual knowledge reflected by the significantly ($P = 0.001$) better test scores of the Group II students after 30 days in comparison to Group I students. However, there was no significant difference with regard to the acceptability of the CAL teaching format alone and along with the conventional teaching format between the two groups ($P = 0.6033$). **Conclusion:** Integrating CAL with conventional teaching format improves students' understanding and performance for a specific topic.

Keywords: Computer-assisted learning, Likert scale, medical education, pharmacology

INTRODUCTION

Today, computers have become an essential part in every walk of life. Undergraduate medical teaching has also been benefitted with the use of computers.[1-11] Several studies have been conducted to assess the utility of CAL tools in undergraduate medical education in different disciplines such as basic disciplines such as anatomy, physiology, and pharmacology and clinical subjects such as dermatology and surgery.[3-12] Pharmacology is a discipline of medical science with deals with drugs such as sources of drugs, chemical nature, routes of administration, pharmacokinetic properties (absorption, distribution, metabolism, and elimination of drugs following entry in the body), pharmacodynamic properties (effect of drugs on various systems of the body; at receptor/molecular level),

different clinical indications, contraindications, interaction with other drugs, and adverse drug reactions (pharmacovigilance).

Traditional teaching format includes mainly didactic lectures with the help of various teaching aids; this form of teaching is considered to be more or less passive way of learning. However, practical classes where the students can actively take

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part in experiments to apply the knowledge obtained from the theory classes is a form of active learning.

Teaching of pharmacology includes both didactic lectures (traditional format) as well as laboratory-based practical classes, involving *in vivo* and *in vitro* experiments (both requiring animals). Recently, the use of animals for experimental purposes in basic sciences is not encouraged because of ethical issues and the easy and cheap availability of effective software programs. Hence, computer-assisted learning (CAL) tools have now become an effective replacement for conventional animal experiments.[13]

CAL techniques include different computer-based packages; for pharmacology, CAL includes series of animal experiments to understand the basic concept of particular drug action on particular systems and specific experimental techniques. Moreover, it is already established that students learn better if they actively participate in the learning process rather than remain as passive recipients.[4]

Literature search reveals that CAL clearly offers potential for improving student learning which is further supported by the fact that CAL has been included in the medical curriculum in about 95% of medical schools in the US and 100% of medical schools in the UK and Canada.[14] However, most of the data are obtained from Western countries; few studies have been carried out in the setting of developing countries like ours (India).[3,4,11,13]

In our state, the syllabus of pharmacology for MBBS students as per the university guidelines include animal experiments, both in *in vivo* (demonstration of "effects of mydriatics and miotics in Rabbit's eyes") and *in vitro* (demonstration of "drug effects in amphibian heart/cat blood pressure preparation") settings.[15] Other than our state, other universities of different states, and several autonomous institutes in India also include animal experiments (in *in vivo* and or *in vitro* settings) in MBBS syllabus.[16-18] However, in accordance with the three R (replacement, reduction, and refinement) principles and the growing ethical concerns against animal experiments, software-based CAL tools would be ideal replacements for animal experiments. In this study, we have conducted a comparative study to identify if there is any benefit of integrating CAL with conventional teaching format (didactic lecture) with the aid of kymographic tracings obtained from previously conducted animal experiments available in books[19] in pharmacology for a specific topic.

MATERIALS AND METHODS

Study site
The study was conducted in a Government Medical College in Eastern India (Kolkata) enrolled under the West Bengal University of Health Sciences and the Medical Council of India. Permission regarding conducting the study was sought from the Institutional Ethics Committee.

Study tools
Conventional teaching format
In this format, the students were taught in the conventional chalk and talk approach without any audio-visual aid other than photocopies of kymographic tracings.

Computer-assisted learning tool
As a CAL tool, we used the software EP Dog version E 1.1.0 (Professor, Department of Pharmacology, JIPMER, India) developed by Dr. R Raveendran. The aim of the session was to demonstrate and explain the effects of various drugs of the autonomic nervous system (ANS) on mean arterial pressure (MAP) and heart rate (HR) in a dog model. The objective of this teaching session was to familiarize the students with the experimental techniques on dog model (anesthetization and preparation of the animal, techniques measurement of MAP and HR, routes of administration of the concerned drugs, etc.), effects of administration of various drugs (agonists and antagonists) acting on the ANS on MAP and HR, comparison of effects, and pharmacological phenomena (vasomotor reversal of dale, ganglionic effects of acetylcholine, etc.,).

The said CAL tool followed two approaches: one was the "Tutorial mode" and the other one was the "Examination" mode. In the "tutorial mode," students were given brief introduction to the techniques, drugs concerned, and also the drug effects on MAP and HR (topic "Effects of different drugs on mean arterial blood pressure in an anesthetized dog"); however, in the "Examination" mode, an unknown drug was provided along with some known drugs, the student was to identify the unknown substance by comparing its effects with the given known drugs.

We chose only the tutorial mode for this study.

Likert scale was used to assess the acceptability of the particular CAL tool in comparison to the traditional teaching format. The assessment was based on the following points; enjoyment, usefulness, ability to arouse interest, and comprehensiveness. It was a four-point scale with each point carrying marks from one (lowest) to five (highest).

Subjects
All the students of a Tertiary Care Government Medical College and Hospital in Eastern India, of the fourth-semester batch (150 in number) were randomized into two groups (Group I and Group II).

Interventions
Students of Group I received a structured lecture on the topic with the help of photocopies of kymographic tracings of the said drug effects on MAP, whereas students of Group II were taught the same topic using the said CAL method (EP Dog version 1.1.0) and photocopies of kymographic tracings. The total teaching period for both the groups was 1 h each. To avoid any bias with regard to the teacher, the same teacher taught the students of both the groups at different time. However, all the students sat for the assessment examination at the end

of respective sessions and for assessment after 30 days all of them appeared for the multiple-choice question (MCQ) test at the same time (students mentioned their respective groups on the answer scripts).

Assessment

At the end of each of the session, the students of both the Groups (I and II) completed short written assessment tests comprising:
1. Likert scales: Asking students on following points; how much they enjoyed, found useful, found interesting, and how well they understood the topic
2. MCQs: To assess the understanding of students of the topic. There were altogether 15 MCQs in each set of questions (five questions to assess techniques involved in animal experiment setup, five questions to assess general understanding of the topic, and five questions to assess understanding of particular drug action); each MCQ carried four responses of which only one was correct. Before conducting the study, the MCQs were set by the junior faculty members of the Department of Pharmacology except the teacher teaching the two groups of students. The validity of the MCQs was ensured by the senior faculty members (experts) and by field testing on fifty BDS students (fourth semester).

Again, after 30 days of either of the sessions, the same set of students answered another set of MCQs on the same topic to assess residual knowledge of the students on the same topic.

Analysis

All the data were analyzed with the GraphPad QuickCalcs software (©2016 GraphPad Software, Inc., USA). Unpaired *t*-tests were used to compare the Likert scale scores (to compare acceptability of the CAL tool to that of the traditional teaching format) and the student scores (to assess the superiority of the CAL tool with respect to traditional teaching format, if any). $P < 0.05$ was considered statistically significant.

RESULTS

Out of the 75 students randomized to Group I, 55 attended the session, whereas out of the 75 students selected for Group II, sixty attended. Greater proportion of male students attended the session; for Group I, 60% males versus 40% females and for Group II 70% males versus 30% females. However, these differences were not statistically significant.

Although there were no statistically significant differences ($P = 0.6033$) in terms of acceptability (assessed by Likert scale) in both the groups of students, the Likert scale score was higher among Group II students [Tables 1 and 2].

After analyzing the scores of the two different groups of students, an interesting result comes out. Test scores just immediately after the teaching show that scores of students taught in conventional format do not differ significantly with those of students taught using CAL ($P = 0.1260$). However,

Table 1: Assessment of acceptability of teaching session in both the groups (Group I and Group II) in terms of enjoyment, usefulness, interest, and understanding

Likert scale	Score	Group I, $n=55$ (%)	Group II, $n=60$ (%)
Enjoyment	5	5 (9)	10 (16.67)
	4	14 (25.45)	16 (26.67)
	3	25 (45.45)	22 (36.67)
	2	11 (20)	12 (20)
	1	0	0
Usefulness	5	10 (18.18)	14 (23.33)
	4	18 (32.72)	16 (26.66)
	3	20 (36.36)	18 (30)
	2	7 (12.73)	12 (20)
	1	0	0
Interest	5	5 (9.09)	15 (25)
	4	23 (42)	16 (26.7)
	3	15 (27.3)	20 (33.33)
	2	12 (21.9)	9 (15)
	1	0	0
Understanding	5	20 (36.36)	24 (40)
	4	15 (27.27)	18 (30)
	3	10 (18.18)	10 (16.67)
	2	10 (18.18)	8 (13.33)
	1	0	0

Table 2: Analysis of five point-Likert scale scores on students' acceptability of the teaching sessions: Unpaired *t*-test

	Group I	Group II
Mean±SD	49.31±28.12	54.44±27.06

$P=0.6033$. SD: Standard deviation

interestingly, test taken after 30 days of teaching showed that students taught using CAL had significantly better residual knowledge compared to their counterparts ($P = 0.001$) based on the scores of MCQ assessment tests [Table 3].

DISCUSSION

We have to keep in mind that in our education system, the principal mode of teaching starting from primary schools is teacher or facilitator based, i.e., conventional format, so students are more comfortable with this type of format.[1,4] Moreover, conventional teaching format has its own appeal as students get the opportunity of interaction with the teachers who can some time act as role models and students ask and resolve their queries immediately. However, in case of CAL, where the predesigned software guides the students, these advantages are missing except, for some specific topics, where visual impression is important. Earlier animal experiments helped students in better understanding of these topics, but with current restrictions on animal experiments, CAL can be used as an alternative to animal experiments.[13]

Table 3: Analysis of multiple-choice question test scores of students (Group I and Group II): Immediately and 30 days after teaching sessions

	MCQ test scores immediately after teaching		MCQ test scores 30 days after teaching	
	Group I (*n*=55)	Group II (*n*=60)	Group I (*n*=55)	Group II (*n*=60)
Mean±SD	8.34±1.4	7.89±1.7	6.4±1.1	9.65±1.2
P (two-tailed)	0.1260		0.001	

SD: Standard deviation, MCQ: Multiple-choice question

In this study, the students of both the groups (Group I and II) received structured lecture with the aid of kymographic tracings (obtained from previously performed animal experiments, available in book);[19] however, the students of Group II additionally got exposure to the said CAL tool. Hence, in our study, no animal was used.

In this study, using the CAL tool did not show any special edge in terms of student acceptability or immediate student performance (assessed by assessing the scores of MCQs in both the groups) over conventional teaching format for a specific topic; however, it (CAL) definitely helped the student in the long run when residual knowledge matters.

Hence, although conventional teaching format is the main format of teaching, for some specific topic, CAL should also be included in the curriculum for better retention of the knowledge and also as an alternative to animal experiments.

During planning of the study, we anticipated two most important likely constraints, namely, poor attendance (unwilling students) and bias during evaluation of the answer scripts. To overcome the constraints, students were adequately counseled (they took the test anonymously, scores not to be disclosed, etc.) but still many of the students did not took part in the study. Again, to minimize any kind of bias during evaluation of student performance, the MCQs were set by a different group of teachers (not taking part in the study) and correct answers were decided before evaluation of the answer scripts.

The most important limitations of our study are the small sample size and the short duration. To address the first limitation, it would have been better if we could involve undergraduate medical students of the fourth semester batch from other medical colleges under the same university (colleges that follow the same syllabus and the same pattern of teaching formats). To overcome the second limitation, it would have been ideal to assess the students at the beginning, i.e., during the fourth semester and at the end of 2nd year, i.e., during the fifth the semester. Another flaw in our study is that we should have conducted assessments (using the same set of MCQs) before teaching (either in conventional way or in both conventional way and with the aid of CAL tool) for better evaluation of the effectiveness of the two interventions (traditional teaching format or CAL tool). Furthermore, for better assessment of retention of knowledge, we should have assessed the students of both the groups beyond 30 days.

CONCLUSION

Although there is no substitution of conventional teaching methods, in this new era of information technology, we can help to improve students' understanding and performance for a specific topic through integration of specific CAL tools with conventional lecture without the help of animal experiments.

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Conflicts of interest
There are no conflicts of interest.

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