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Original Research Article

A questionnaire-based comparison of conventional teaching methods to computer assisted learning in experimental pharmacology for undergraduate medical students

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ABSTRACT

Background: Computer Assisted Learning (CAL) for teaching experimental pharmacology is now widely accepted as alternative to animal experiments. The objective of this study was to compare the performance of undergraduate medical students by conventional teaching methods (lecture and discussion) and CAL.

Methods: This was a questionnaire based observational study involving 109 MBBS students of fifth semester. The students were taught experimental pharmacology practical by both conventional methods (lecture with discussion) and computer assisted learning (CAL). Questionnaire and their filled responses by these students were taken at the end of lecture-discussion (pre-CAL) and after the CAL experiments (post-CAL), covering the same topics of experimental pharmacology. Pre-CAL and post-CAL data were assessed statistically.

Results: In the pre-CAL session, only 53.39%, 47.56%, 53.39% and 49.5% of the students were having the scores above 40% in the rabbit eye, DRC and potentiation, frog heart and dog BP experiment respectively, which was increased to 77.44%, 75.48%, 75.47% and 75.48% of the students respectively in the post-CAL assessment. A statistically significant difference ($p < 0.05$) in the performance was observed among the students in the pre-CAL and post-CAL assessment.

Conclusions: CAL is a good alternative to animal experimentation. Lecture with discussion, followed by CAL experiments on the same topics, enhanced the performance of students as shown by improvement in post-CAL scores.

Keywords: Animal experiments, Computer assisted learning, Experimental pharmacology

INTRODUCTION

Pharmacology is both a basic as well as applied subject taught to undergraduate medical students in their 3rd, 4th and 5th semesters. The subject encompasses the basic fundamental concept about the drugs and their effect on normal physiology as well as in the diseased states. The curriculum of undergraduate pharmacology is divided as theory lecture and practical. The practical section in

pharmacology includes pharmacy, experimental and clinical pharmacology.¹

As per the guidelines of UGC (University Grants Commission) and MCI (Medical Council of India), the animal experiments are banned in India for teaching purpose and these are replaced by computer models and simulation experiments.² Simulation experiments via CAL offer the effective implementation of 3 'R's (Reduction, Refinement and Replacement) in animal experiments.³

Both in-vitro and in-vivo experiments were previously taught to the undergraduate medical students by using animals but experiments on CAL not only avoids the unethical sacrifice of animals, but also is time saving, cost-effective, repeatable and incorporates to a better understanding and acquisition of cognitive domain of learning to the students.⁴ A number of studies have been conducted earlier on the perception of students about CAL as teaching method, including its advantages and disadvantages, but very few studies were conducted on the performance of the students on the major topics of experimental pharmacology at undergraduate level.⁵⁻⁹ The present study was aimed to evaluate the performance of students on conventional teaching methods (such as lecture and demonstration) followed by CAL experiments on the same topics of experimental pharmacology.

METHODS

This questionnaire-based study was conducted at Department of Pharmacology, Heritage Institute of Medical Sciences (HIMS), Varanasi, Uttar Pradesh, India. One hundred and nine (109) MBBS students in their fifth semester were the participants in this study. The participants were explained about the study and their participation was voluntary after obtaining the informed consent from them.

The experimental pharmacology practical was discussed in detail to these students by classroom lectures in 3rd and 4th semesters and by simulated experiments by CAL method in 4th and 5th semesters. A questionnaire consisting of four major sections which were rabbit eye experiments, DRC on frog rectus abdominis and potentiation effect of physostigmine, cardiac stimulants and depressants on isolated and perfused frog heart and dog BP experiments was prepared by the faculty members of the Department of Pharmacology, HIMS. Each section of the questionnaire comprised of five multiple choice questions (MCQs) with a single correct response, so a total of 20 questions were included in the questionnaire.

After the completion of classroom lectures on these four topics of experimental pharmacology, at the end of 4th semester, CAL experiments were started on these same topics. The filled responses of the questionnaire from these students were collected at the end of classroom lectures but before the start of CAL experiments (pre-CAL) and at the completion of CAL experiments (post-CAL). Out of 109 students, six and seven students did not participate in the pre-CAL and post-CAL study respectively, so these were excluded from the total number of students participated in this study. After the initial 15 minutes briefing about the study, the students were provided 30 minutes time to fill the responses of the questionnaire independently. One hundred three (103) pre-CAL and 102 post-CAL filled questionnaires were collected from the students and analyzed statistically using two-sided p value at a 5% level of significance.

RESULTS

In the section of rabbit eye experiments of the questionnaire, 46.59% of the participants were having pre-CAL score equal to or below 40%, while in the post-CAL assessment only 22.54% of the participants were having the same score. In the pre-CAL session, only 53.39% of the participants scored above 40%, this was increased to 77.44% of the participants in the post-CAL session. There was a statistically significant difference in the performance among the students in the pre-CAL and post-CAL assessment in rabbit eye experiments (chi-square statistic 15.420, p-value <0.05) (Table 1).

Table 1: Questionnaire based comparison in rabbit eye experiments.

Score		Pre-CAL (N=103)		Post-CAL (N=102)	
No.	%	No. of students	%	No. of students	%
5	100	14	13.59	26	25.49
4	80	18	17.47	29	28.43
3	60	23	22.33	24	23.52
2	40	25	24.27	10	9.80
1	20	13	12.62	07	6.86
0	00	10	9.70	06	5.88
$\chi^2=15.420$, $df=5$, $\chi^2/df=3.08$, 'p'<0.05					

In the section of DRC and potentiation experiments on frog rectus abdominis of the questionnaire, 52.41% of the students were having pre-CAL score equal to or below 40%, which was reduced to only 24.5% of the participants in the post-CAL session with similar score. In the pre-CAL session, only 47.56% of the students scored 40% and above which was increased to 75.48% of the participants in the post-CAL session. This was shown by a statistically significant difference in their performance in the pre-CAL and post-CAL assessment in DRC and potentiation experiments (chi-square statistic 18.357, p-value <0.05) (Table 2).

Table 2: Questionnaire based comparison in DRC and Potentiation experiments.

Score		Pre-CAL (N=103)		Post-CAL (N=102)	
No.	%	No. of students	%	No. of students	%
5	100	15	14.56	22	21.56
4	80	13	12.62	27	26.47
3	60	21	20.38	28	27.45
2	40	26	25.24	11	10.78
1	20	17	16.50	07	6.86
0	00	11	10.67	07	6.86
$\chi^2=18.357$, $df=5$, $\chi^2/df=3.67$, 'p'<0.05					

In the frog heart experiments portion of the questionnaire 46.58% of the students scored ≤40% which was reduced to only 24.5% of the students in the post-CAL session. Only

53.39% of the students scored above 40% in the pre-CAL while this was increased to 75.47% of the students in the post-CAL session. Statistically significant difference was seen in the pre-CAL and post-CAL performances in the frog heart experiments (chi-square statistic 16.123, p-value <0.05) (Table 3). In the dog BP experiment section of the questionnaire 50.47% of the students scored equal to or below 40%, this was reduced to 24.5% of the students in the post-CAL session. Only 49.5% of the participants were having the pre-CAL score above 40% and this was increased to 75.48% of the students in the post-CAL session. Statistically significant difference was also seen in the pre-CAL and post-CAL performances in the dog BP experiments (chi-square statistic 15.188, p-value <0.05) (Table 4).

Table 3: Questionnaire based comparison in frog heart experiments.

Score		Pre-CAL (N=103)		Post-CAL (N=102)	
No.	%	No. of students	%	No. of students	%
5	100	12	11.65	25	24.50
4	80	19	18.44	32	31.37
3	60	24	23.30	20	19.60
2	40	22	21.35	10	9.80
1	20	15	14.56	07	6.86
0	00	11	10.67	08	7.84
$\chi^2=16.123$, $df=5$, $\chi^2/df=3.22$, 'p'<0.05					

Table 4: Questionnaire based comparison in dog BP experiments.

Score		Pre-CAL (N=103)		Post-CAL (N=102)	
No.	%	No. of students	%	No. of students	%
5	100	13	12.62	22	21.56
4	80	17	16.50	26	25.49
3	60	21	20.38	29	28.43
2	40	19	18.44	09	8.82
1	20	18	17.47	10	9.80
0	00	15	14.56	06	5.88
$\chi^2=15.188$, $df=5$, $\chi^2/df=3.04$, 'p'<0.05					

DISCUSSION

This questionnaire-based study compared the performance of undergraduate medical students by conventional teaching methods (lecture and discussion) with CAL, by giving a questionnaire at the end of teaching sessions on the same topics of experimental pharmacology by both conventional teaching methods and CAL. It was observed that the students taught by CAL method after the discussion of topics by lecture and discussion scored better. There was a statistically significant difference (p <0.05) in the performance among the students in the pre-CAL and post-CAL assessment in all the four sections of the questionnaire incorporating the rabbit eye, DRC and

potentiation, frog heart and dog BP experiments. The findings of this study were consistent with similar studies conducted earlier.¹⁰

Advantages of CAL

CAL experiments enable the students to complete the major 5-6 simulated experiments in one- or two-month's schedule with rotation of batches. It is much less expensive than animal experiments, because it minimizes the costs for animal procurement, expenditure on their diet, maintenance and care at the animal house.^{11,12} The CAL experiments can be repeated two to three times in a year for revision purpose and better understanding without any extra monetary burden. The longer experiments such as three point or four-point bioassay usually takes about 3-4 hours on animal tissue but only about one hour in CAL. The total batch of 100-200 students can perform 5-6 different CAL experiments on different computers simultaneously which is practically impossible with animal experiments. Experimental errors due to biological variation or methodological errors commonly encountered during animal experiments but are totally excluded in CAL experiments.¹³ The CAL experiments help in better understanding of the theoretical concepts, if performed simultaneously or just after theoretical lecture and discussion. CAL experiments help in improvement of cognitive skill rather than psychomotor skill. In short, CAL is time saving, cost effective, minimizes the errors, easy to perform and helps in the better understanding.^{14,15}

Disadvantages of CAL

The software available for CAL experiments has a fixed pattern in the experiments that can be rarely altered or changed. The students have to follow that fixed pattern and they are never exposed to the biological or methodological variation as observed in animal experiments. CAL minimizes the acquisition of psychomotor or technical skill.¹⁶

CONCLUSION

It was concluded that CAL is a welcome change as alternative to animal experiments. CAL helps in better understanding of the fundamental concepts and further if combined with theoretical discussion.

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Conflict of interest: None declared

Ethical approval: The study was approved by the Institutional Ethics Committee

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Appendix

Questionnaire for pre-CAL and post-CAL assessment of Experimental Pharmacology Practical
<p>Instructions:</p> <ul style="list-style-type: none"> • Participation in this questionnaire-based study is voluntary • Do not write your name or roll number • Tick mark on only one response of each question • Attempt all the questions in the given sequence on questionnaire
<p>Section A (Rabbit eye experiments: miotic, mydriatic and local anaesthetic)</p>
1) Passive mydriasis and abolished light reflex is seen with (a) Atropine (b) Phenylephrine (c) Pilocarpine (d) Lignocaine
2) Active miosis is seen with (a) Atropine (b) Phenylephrine (c) Pilocarpine (d) Lignocaine
3) Abolished corneal reflex is seen with (a) Atropine (b) Phenylephrine (c) Pilocarpine (d) Lignocaine
4) Active mydriasis is seen with (a) Atropine (b) Phenylephrine (c) Pilocarpine (d) Lignocaine
5) Blockade of dilator pupillae and unopposed action of sphincter pupillae results in (a) Active miosis (b) Active mydriasis (c) Passive miosis (d) Passive mydriasis
<p>Section B (DRC and Potentiation experiments on frog rectus abdominis)</p>
6) In a log DRC the graph/curve obtained is (a) hyperbolic (b) S-shaped (c) L-shaped (d) Bell shaped
7) In the Potentiation effect, the changes observed in log DRC (a) left shift (b) right shift (c) flattening (d) unchanged
8) The first dose which elicits the maximum biological response in a tissue is called (a) threshold dose (b) ceiling dose (c) loading dose (d) minimum dose
9) The PSS used in frog rectus abdominis experiment (a) Frog Ringer (b) Tyrode (c) Ringer Locke (d) De-jalon
10) In frog rectus abdominis experiment, the receptor involved for the action of acetylcholine is (a) N_N (b) N_M (c) M_2 (d) M_3
<p>Section C (cardiac stimulants and depressants in frog heart experiments)</p>
(11) Positive chronotropic action is due to these receptors (a) β_1 (b) β_3 (c) M_1 (d) M_3
(12) Systolic arrest of prolonged duration is produced by (a) KCl (b) $CaCl_2$ (c) acetylcholine (d) $MgSO_4$
(13) Diastolic arrest of prolonged duration is produced by (a) KCl (b) $CaCl_2$ (c) adrenaline (d) $BaCl_2$
(14) Effect of cholinomimetics in heart (a) Positive chronotropic and positive inotropic effect (b) Negative chronotropic and negative inotropic effect (c) Positive chronotropic and negative inotropic effect (d) Negative chronotropic and positive inotropic effect
(15) In the presence of atropine, effect of all of these drugs can be observed except (a) Acetylcholine (b) adrenaline (c) KCl (d) $CaCl_2$
<p>Section D (Dog BP experiments)</p>
(16) Biphasic action on BP is observed with (a) Epinephrine (b) Norepinephrine (c) atropine (d) isoprenaline
(17) Dale's vasomotor reversal is not seen with Norepinephrine due to lack of action at (a) α_1 receptor (b) β_1 receptor (c) α_2 receptor (d) β_2 receptor
(18) Cardiovascular actions of Norepinephrine are (a) \downarrow HR and \downarrow BP (b) \uparrow HR and \uparrow BP (c) \downarrow HR and \uparrow BP (d) \uparrow HR and \downarrow BP
(19) Cardiovascular actions of Isoprenaline are (a) \downarrow HR and \downarrow BP (b) \uparrow HR and \uparrow BP (c) \downarrow HR and \uparrow BP (d) \uparrow HR and \downarrow BP
(20) Observations of nicotinic actions of acetylcholine are (a) \downarrow HR and \downarrow BP (b) \uparrow HR and \uparrow BP (c) \downarrow HR and \uparrow BP (d) \uparrow HR and \downarrow BP