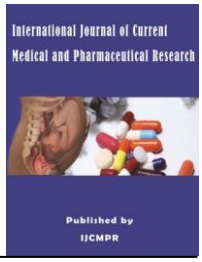
Research Article

INTERNATIONAL JOURNAL OF CURRENT MEDICAL AND PHARMACEUTICAL RESEARCH

ISSN: 2395-6429, Impact Factor: SJIF: 4.656
Available Online at www.journalcmpr.com
Volume 8; Issue 09; September 2022; Page No. 390-394
DOI: http://dx.doi.org/10.24327/ 23956429.ijcmpr20220089



PERCEIVED USEFULNESS AND BENEFICIAL LEARNING OUTCOMES IN STUDENTS OF PHARMACOLOGY INTRODUCED TO COMPUTER SIMULATED EXPERIMENTS

Serah Johny[1], Nisha M[2], Jolly Varghese[3], Susan Mani,[4] Anna Mathew*[5] and Kalesh M Karun[6]

[1,2,3,4,5]Department of Pharmacology, MOSC Medical College, Kolenchery
[6]Biostatistician, MOSC Medical College, Kolenchery, Kerala

ARTICLE INFO

Article History:

Received 10th June, 2022
Received in revised form 18th July, 2022
Accepted 25th August, 2022
Published online 28th September, 2022

Key words:

Computer simulated learning, perceived usefulness, learning outcomes

ABSTRACT

The removal of animal experimentation and the availability of excellent computer-based simulations demonstrating drug action, has made computer simulated experiments a valuable instructional tool for teaching pharmacology. After ethics committee approval, 172 pharmacology student volunteers participated in the study after giving written informed consent. A multiple-choice pre-test was administered prior to the computer-based teaching sessions using the software EP Dog version E 1.1.0. followed by a questionnaire to gather student perceptions and personal learning outcomes. A post-test was used to assess learning. Students expressed a positive attitude to computer-based learning and were able to perceive the usefulness, ease of use and positive learning outcomes. The post-tes showed a significant increase in knowledge acquired. In conclusion the study shows that computer simulated experiments are a very effective teaching- learning method with the potential to raise teaching standards in pharmacology.

INTRODUCTION

Animal experiments have been an integral part of the pharmacology education in medical colleges in India for many years.[1] However in recent times, ethical concerns, difficulty in procuring animals and strict regulations have forced us to look for alternative methods that avoid animal experimentation. Two clear guidelines that have evolved are to generate a clinical orientation to the teaching of pharmacology and to use innovative simulations both to develop skills and to teach the concepts of drug action.[2,3]In India, the graduate medical curriculum has been revised to include cognitive or intellectual skills such as the learning of concepts of drug action, psychomotor skills such as the preparation and administration of drugs and attitudinal or communication skills such as patient motivation and self-learning skills.[4] The laboratory based practical classes have supplemented classroom learning in the development of these skills. Though animal experiments have been removed, with the rapid development of information technology, newer trends in teaching and computer simulated learning are available to supplement classroom teaching by creating a virtual clinical experience using computers.[5, 6]

Computer assisted learning software is now available that provide a collection of animal experiments that encourage students to understand concepts in pharmacology. It is an interactive computer assisted learning program without the involvement of real experimental tools. The program can be repeated over any number of times without the use of animals.[7] It helps to achieve a greater theoretical understanding of the experiments as simulations mimic the actual experimental set up in the laboratory. Computer simulated experiments (CSE) have now become an integral component of the pharmacology curriculum in various medical schools in India.[8]A number of studies from various medical schools have documented the effectiveness of computer assisted learning in terms of knowledge acquisition and achieving learning objectives in developing skills.[9–12].

In our institution we have actively developed a mannequin model to help the development of psychomotor skills in drug preparation and administration, which is now part of the curriculum, using objective structured practical examination as the assessment method.[13] Since 2018, when a computer lab was established in our institution, CSE has been included in the pharmacology curriculum of our medical college to encourage the conceptualisation and development of cognitive skills of drug action.

It has been shown that students' attitudes towards the computer such as valuing the potential of the computer, enjoyment of it's use and computer anxiety directly influence their acceptance of using the computer as a learning tool.[14]Studies have indicated that perceived usefulness, perceived ease of use, and subjective norms were significant predictors of attitudes to computer simulated learning. Davis developed the Technology Acceptance Model which derives two variables which determine attitude to using technology for learning.

These variables are perceived usefulness, and perceived ease of use. Perceived usefulness refers to the extent to which people believe a technology will help them to do a better job, and perceived ease of use shows the ease or lack of effort to

*Corresponding author: **Anna Mathew**
Department of Pharmacology, MOSC Medical College, Kolenchery

actually use it.[14, 15]When people believe that the computer is easy to use, nearly free of mental effort, and helpful to learning; their motivation to self-learning using computer simulated experiments may increase considerably compared to what can be achieved by book learning alone. It can be predicted that such people may use computer technologies frequently and intensely.

This study was undertaken to assess the perceptions of students in three areas

A.CSE clearly elucidates drug action

B.CSE is aneasy to use instructional tool and

C.CSE enhances personal learning outcome.

OBJECTIVES

1. To elicit student perceptions on the effiacy of CSE on enhancing learning of drug action
2. To assess the learning of cardinal concepts in drug action using the scores obtained in a pre and post test

MATERIALS AND METHODS

This is a cross sectional study conducted on student volunteers from the second year MBBS students of a medical college in south Kerala. After getting clearance from the institutional review board and the ethics committee, the study was carefully explained to students. Written informed consent was obtained, after informing them that participation in the study was entirely voluntary. All students would receive all the teaching-learning input whether they participated in the study or not and they could withdraw from the study at any time during the process. The knowledge assessment test marks would not be included in their summative assessment.

As a computer simulated learning tool, we used the software EP Dog version E 1.1.0 developed by Dr. R Raveendran, Professor, Department of Pharmacology, JIPMER, Pondicherry, India as an alternative to experimental pharmacology.

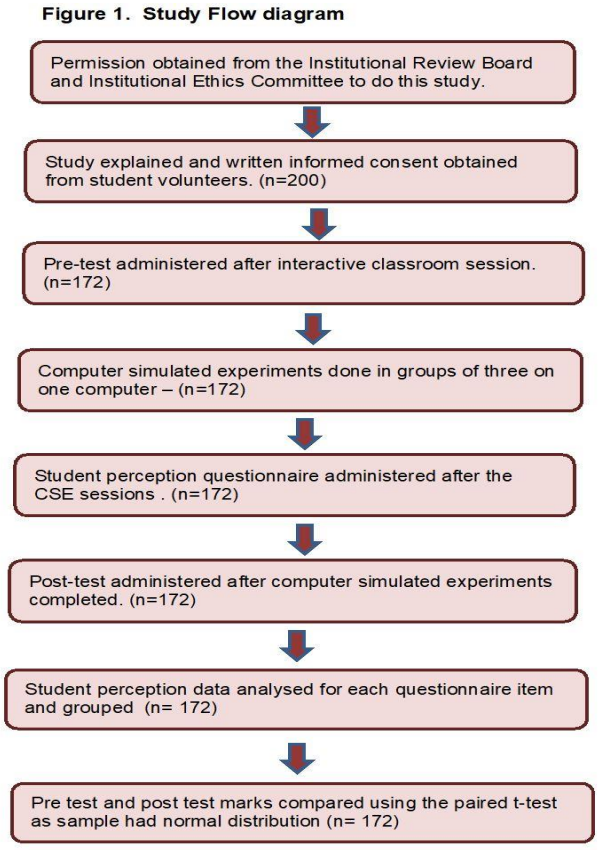
Students worked in groups of three while performing the experiments on one computer. A pre-test was conducted in the form of multiple-choice questions after the interactive lecture sessions prior to the practical experiments. Those students who did not attend the pre-test were excluded from the study. The practical lessons comprised of six computer simulated experiments on anaesthetised dog, showing actions of various adrenergic, histaminergic and cholinergic drugs.

A multiple-choice post-test was conducted to assess the knowledge acquired after the CSE sessions. Student perceptions were elicitedin three sections, using a questionnaire to grade usefulness, ease of use and personal learning outcome.

A. Student perception of usefulness of CSE in representing drug action
B. Student perception on ease of use and process of CSE
C. Student perception on personal learning outcomes

Anonymity of all data was ensured by using study numbers and students were encouraged to honestly indicate their perceptions. The methodology is shown in the study flow chart which is given in Figure 1.

Figure1 The Methodology and Number of Student Participants



Legend for Figure 1 The Study flow chart based on the STROBE guidelines for observational studies shows that 172 students participated in the study and were administered the pre-test., post-test and the student perception questionnaire.

STAISTICAL ANALYSIS

After collection, the data was analysed and summarised for the individual questionnaire items and the results expressed in terms of frequencies and percentages. Knowledge outcome was assessed by comparing the pre and post test results using the paired t-test as the distribution was found to be normal. The test showed a "p" value <0.001, indicating that there is a significant difference between mean knowledge scores before and after the CSE sessions.

RESULTS

Of the 172 student volunteers who took part in the study 109 (63.4%) were female with a mean age of 20.3 years and 63 (36.6%) were male with a mean age of 20.4 years.

Table 1 shows the first section of the questionnaire with the responses of students indicating how they perceive the usefulness of using CSE to study drug action. Most of the responses indicate that students perceived the usefulness of CSE in elucidating and demonstrating the action of drugs.

Table 1 perceived usefulness of cse to demonstrate drug action

Questionnaire item		Student Response (n=172)		
Item No.	Perceived Usefulness of CSE to demonstrate Drug Action	To a little extent	To some extent	To a great extent
A.1.	Does CSL help to demonstrate the drug action where/when animals are not available?	2	26	144
A.2.	Does the graphic response to drug administration	0	9	163

	appropriately represent the drug action on heart rate and blood pressure?			
A.3.	Compared to explaining the drug action alone is CSE a better instructional tool?	3	17	152
A.4.	Would it be better to do study the drug effect on individual computers – alone or in pairs - rather than all together?	34	33	105
A.5.	To what extent does the CSE feel as if you are testing the effect of the drug on a living animal?	16	60	96

Table 2shows the second section on the process of CSE and reflects the ease of use and comfort students had with using CSE as an educational tool. The responses showed that most of the students perceived CSE as an easy to use, student friendly and attention-retaining educational instrument.

Table 2 perceived ease of use of cse as an instructional tool

Questionnaire item		**Student Response (n=172)**		
No.	**B. Perceived Ease of Use of CSE as an Instructional Tool**	**To a little extent**	**To some extent**	**To a great extent**
B.6	Was it easy to study each drug with few pre-fixed doses than all graded doses?	24	52	96
B.7	Was the visual input complementary to the auditory teaching input?	3	21	148
B.8	Was the fact that no variations were possible as happens with living animals easier in learning concepts?	7	60	105
B.9	Was the instructional material given helpful to supplement the visual and graphic input?	4	23	145
B.10.	Was the CSE an easy to use, interesting and attention-retaining tool, with no major problems?	2	17	153

Table 3 indicates the perceptions students have of their learning outcomes. Student perceptions on their personal learning were uniformly positive and indicated that the perceived learning outcome was good.

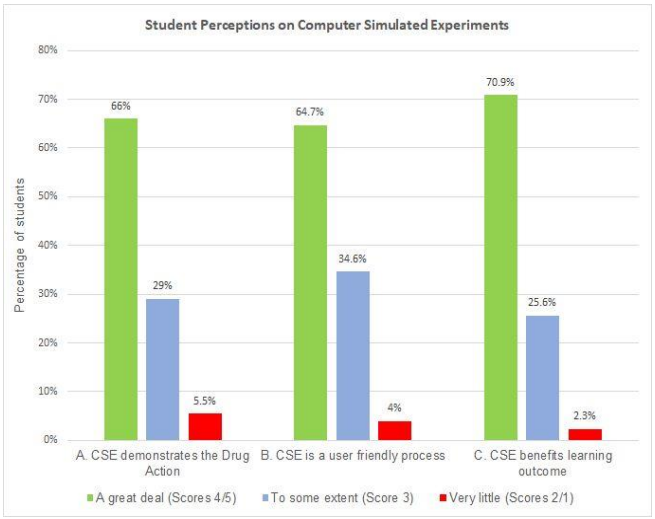
Table 3 student perceptions on personal learning outcomes

Questionnaire item		Student Response (n=172)		
No.	C. Student Perceptions on Personal Learning Outcomes	To a little extent	To some extent	To a great extent
C.11.	Compared to lecture alone how effective was the CSE for your personal learning of drug action?	1	12	159
C.12.	Did the effect of giving drug on the screen clarify for you personally the drug action?	3	20	149
C.13.	For you personally, would drug action be retained better in your memory because of CSE?	4	32	136
C.14.	Would you have missed a great personal learning experience if you had NOT attended the CSE class?	7	27	138
C.15.	Was the personal learning effectively achieved inspite of the fact that it was contrived and not on real live animals?	8	37	127

Figure 2represents the student perceptions in the areas of

A. CSE clarifies drug action (usefulness of CSE to study drug action),
B. CSE is a User-friendly process (ease of use of CSE) and
C. CSE benefits learning outcome.

Figure 2 student perceptions



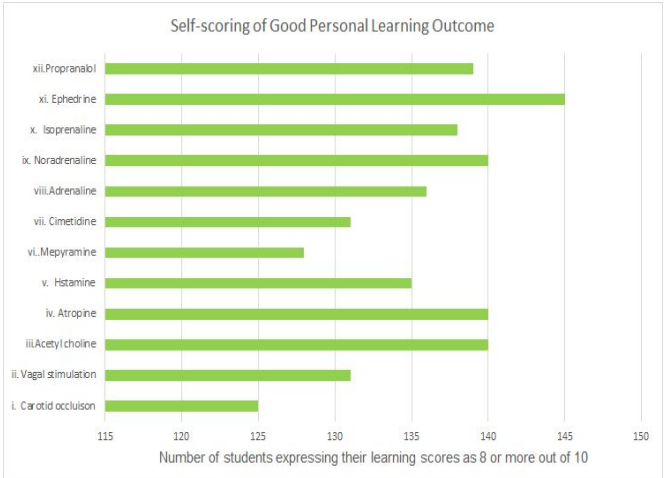
Legend for Figure 2

Over 65% of responses indicated learning to a great extent with scores of 4 or 5. This indicates that the perceived usefulness of the tool in demonstrating drug action was very good.

Perception of students on Conceptualising Drug Action

The students rated their personal learning of individual drug action on a rating scale of 1 to 10, with 10 indicating excellent learning and 1 little learning. Figure 3 shows a clustered bar chart showing the number of students who scored themselves 8 or more on the scale to indicate their personal learning experience.

Figure 3 self-scoring of personal learning outcomes



Legend for figure 3 Of the 172 students who scored their learning outcomes on a scale of 1 to 10, more than 70% gave

themselves a score of 8 or more for the learning of each of the drug actions.

Learning Outcome assessment

A pre-test was conducted prior to starting the CSE sessions. Two weeks after the completion of the computer simulated experiments residual knowledge assessment was done with the help of a post-test comprising of objective type of multiple choice questions. 172 students took the pre and post test. As the data followed normality, statistical analysis was done using the paired t-test. The test showed a "p" value <0.001, indicating that there is a significant difference between mean knowledge scores before and after the CSE sessions. Table 4 shows the mean test marks and the increase in learning that has taken place. We can infer that significant learning has taken place during the CSE practical sessions.

Table 4 assessment of knowledge acquired

	Mean	Standard deviation	T statistics	p value
Pre-test marks	7.21	2.407	- 37.82	<0.001*
Post-test marks	15.55	2.292		

DISCUSSION

Lecture-based teaching is an effective educational tool in communicating knowledge but contributes little to experiential learning, and educators are often confronted by a theory-practice gap.[14] Just as simulated learning using mannequins can develop the psychomotor skills in drug preparation and administration so CSE can help the student to develop intellectual skills by visualising the effects of a drug and learning the basic concepts of drug action. As in setting up a skills lab, the initial investment and effort is required so it is with setting up of a computer laboratory. In addition to the high initial investment, there is the regular requirement of adequate technical support and maintenance, However these pale into insignificance when we consider the benefits of the higher quality and content of student learning. The availability of dependable software helps the student to have a hassle-free learning experience at their own pace.

Introduction of computers in schools has made it easier for our students to lose their fear of computers and recognise that it is easy to use them. We found our students easily perceived that CSE is a valuable resource for their learning and creative teachers can use this tool to greatly enhance student learning.
The main objective of this study was to assess student perspectives and learning using CSE as an instructional tool. The removal of animal experiments from the student curriculum deprives the students of hands-on learning of drug action that takes place when observing administration of the drug to an animal and the students were able to appreciate that CSE fills this gap and enables them to observe the actual drug action with the help of computer simulation.

It is difficult for students to conceptualize the action of drugs using only classroom teaching and graphs and students expressed that they were able to retain the drug action in their memory much better when the classroom teaching was supplemented with CSE. We observed that CSE provides additional learning benefits to those students whose learning style is "visual" or "kinesthetic" as they receive visual input and use the mouse to observe the drug action and comprehend how the drug acts. It is a practical way for students to observe exactly what happens when the drug is administered and what the eye sees is easier for the mind to remember.

The questions in our questionnaire were framed to study the perceptions of students regarding the perceived usefulness in learning drug action, the perceived ease of use of CSE and their perceived personal learning outcomes. These embody the principles of adult learning. Students who are convinced about the value of CSE in learning will have a higher sense of self-direction and motivation. As the student finds CSE facilitates learning and helps to conceptualise the drug action he/she develops an acceptance of this way of earning. CSE is a user-friendly tool and students are happy to choose it as a preferred learning tool in comparison to traditional book learning, We will look at the student perceptions in each section and then consider the knowledge gained as reflected in the improvement shown in the post-test marks.

Student Perceptions

Perceived Usefulness

The questions in Section A relate to the perceived usefulness of CSE to demonstrate the given drug action. In comparison to conventional teaching, 152 (88.4%) students perceived that CSE is a better instructional tool that can be incorporated into the regular teaching of pharmacology. In the absence of animal experiments, 144 (83.7%) students perceived that CSE was very helpful in demonstrating the drug action and making concepts clear about drug action. Of the 172 participants, 163 (94.7%) students felt the graphic representation of drug action on heart rate and blood pressure was appropriately represented in the CSE. Though 96 (55.8 %) students felt as if they were performing the experiments on a live animal, the remaining 44.2% students pointed out that actual hands- on experience with animals was lost. Though working in groups of 3 did not hamper the learning experience, 105 (61%) students suggested that it would be better to study the drug effect on individual computers rather than in groups of three.

Perceived Ease of Use

The questions in Section B related to the process of CSE and the perceived ease of use of this instructional tool. Of the 172 students, 108 (62.8%) would have been liked to study each drug with several graded doses rather than with the few pre-fixed doses. More than 90% of the students agreed that visual input was complementary to the auditory teaching input. More than half the participants, 98 (57%) students said that CSE very much enabled learning even though the variations possible with living animals were not there, while the remaining 39% felt there learning was hampered by this fact. Additional resources were provided to clarify details and 145 (84.3%) students felt the instructional material given was helpful and supplemented the graphic input. Of the 172 students, 153 (90%) felt the CSE was an interesting and attention-retaining tool which was user friendly and dependable for learning agonist/ antagonist interactions.

Perceived Learning Outcomes

Section C was intended to gather student perceptions on personal learning outcomes. More than 80% of the students responded that CSE was more effective than conventional teaching using only graphs. They felt they were better able to retain the concepts of drug action because of the CSE experience. They felt they would have missed a great personal learning experience if they had not had the CSE sessions.

Assessment of Learning

Though we are aware that there are aspects to student learning and marks are not the only indicator, we did conduct a multiple-choice test to assess the knowledge gained on the concepts of drug action two weeks after the CSE sessions were completed. We found there was a significant improvement in the mean scores obtained by the students as compared to the earlier pre-test scores ($p<0.001$)

When students perceive that the instructional tool is easy to use and gives good learning outcomes, it contributes to their "self-efficacy" and they are motivated to use it for their learning. [16]Dewhurst and Norris undertook a project with the goal of testing a strategy to facilitate teacher's use of existing e-learning resources in pharmacology in the UK and found that pharmacology teachers were able to successfully integrate existing CAL resources into courses and were able to enhance student learning at an appropriate level and proving acceptable to both staff and students.[10]

CONCLUSION

Student perceptions show that CSE is a very effective teaching-learning method to demonstrate how drugs act. Students find their learning is enhanced by the demonstration of the cardinal concepts of drug action.

This instructional tool cancreate a paradigm shift in the way of learning pharmacology as students have a positive attitude to computer based learning and are able to perceive the usefulness, ease of use and positive learning outcomes using CSE. In addition there was a significant increase in knowledge acquired as assessed by the post test. In conclusion, computer assisted learning is a feasible and very effective teaching and learning method with the potential to raise teaching standards in pharmacology.

Acknowledgements

We are grateful to the Dean and Management of MOSC Medical College for setting up the computer laboratory in the institution which has made it possible to set up this series of computer simulation experiments as part of the teaching in the Department of Pharmacology in this institution.

The staff of the Pharmacology Department have been most co-operative in being available for these interactive sessions.
We are grateful to the student volunteers for participating in this study and sharing their perceptions.

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