

Computer-Assisted Learning Modules Vs Traditional Teaching Methods in Medical Physiology: Current Perspectives

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ABSTRACT

Animal experimentation on amphibians has traditionally been a part of the practical physiology curriculum in MBBS course. However, difficulties in procurement and maintenance of these animals, ecological concerns and ethical issues have led to a global decline in this trend over the years. Questions have also been raised over its relevance for a medical graduate. With the advancement of technology, computer based simulation modules or video demonstrations are now being advocated as a replacement to the traditional teaching method. Apart from addressing the previous concerns, it also makes the learning process more student-centric. This article attempts to review the work done on assessing effectiveness and student perceptions of these computer-based learning tools.

Keywords: Computer-assisted learning, CAL, simulation modules, animal experiments, medical physiology, teaching methods

INTRODUCTION

Human beings are inquisitive by instinct. This quest for knowledge articulated in the form of meticulous scientific inquiry has been the driving force behind the evolution of human civilization to its present day. Experimentation has been one of the fundamental premises on which this success story has been built. Every new idea, notion or hypothesis has been put to the test of experimentation to ascertain its plausibility and validity. The medical science is no exception to this. It is well known that much of our present understanding of the normal human physiology and medicine is attributed to thorough study of animal experiments. They

have also been at the epicentre of our understanding of how various drugs work and the mainstay of development of new therapeutic tools. In the recent times, animal experimentation has come under considerable criticism on ethical grounds and globally people are now quite sceptical about its relevance in teaching of facts and principles that are already known and established. Today, there is almost a worldwide consensus on the matter of reducing animal experiments in undergraduate medical courses. Studies as back as the early 2000s have shown that majority (68%) of medical schools in the United States had done away with animal experiments in Physiology, Pharmacology

and Surgery clearly underlining that these are not indispensable elements. [1]

Search methodology

Research articles and works on computer assisted learning in undergraduate medical physiology were searched on data bases like Google Scholar, Pub Med, Cochrane Library and Medscape using search engines from 1990 onwards. The search was done with various words and combinations like computer assisted learning, traditional teaching in practical physiology, computer based learning, simulation modules in medical curriculum, alternatives to animal experiments and effectiveness of computer based learning, etc. The types of articles studied for this review were original research, review papers, letters to the editor, guidelines and gazette notifications, etc.

Why have been animal experiments used for teaching physiology?

Physiology is the study of normal functioning and mechanisms of the body, which is a fundamental element for understanding of disease and principles of treatment. Animal experiments have traditionally been a part of its practical curriculum. It strongly relies on animal experiments because it reinforces the conceptual knowledge that a student gains by theoretical reading. [2,3] Students visualize the principles of nerve-muscle physiology and cardiac muscles at play by a series of amphibian experiments. They also observe the effect of certain drugs and ions. Animals were selected for this purpose because of many reasons. Quite understandably, there are obvious ethical issues with human experimentation. And in the decades preceding the technological boom, it wasn't possible to artificially simulate or create the entire complexity of human structure and function, ruling out in practice, the options currently present. Thus, animals were found to be the only suitable alternatives for the broad principle of gaining knowledge.

The imminent transition

Over the years, there has been a gradual changeover from individual performing to demonstration of the animal experiments by instructors only. This has been eventually replaced by demonstration of prepared charts and graphs and most recently, with the aid of computer-assisted learning modules. The resistance to the performing of animal experiments that has led to this transition is multifactorial.

Lack of availability of suitable animals like frogs in the wild and growing concerns over derangement of the delicate ecological balance have served as primary deterrents in this regard. Ethical and moral questions on animal experiments have already been raised since the early twentieth century. Furthermore, these experiments are time consuming and tedious and require a high degree of technical expertise in handling animals, which would not be of much relevance to a future doctor. The cost of purchasing and the efforts into maintaining the animals before an experiment are additional impediments. There are two more important aspects in this issue.

Firstly, there is an influence of the biological variability on the quality of the experiments. The artificial laboratory environment in which the animals are kept and experimented upon invariably stresses the animals. And, stress has its own consequences on the physiology of an organism affecting the working of the heart, blood pressure, hormone levels and immunological activities, etc. These confounding factors would result in deviations far from the normal. [4] Secondly, the technical point too must be taken into account. In demonstration by instructors, the minute details may not be visible to all the students attending the practical session. Also, on a given animal, a single experiment can seldom be repeated.

The guiding principle in the present day that balances both quest of knowledge and the quest for ethical uprightness is embodied in the 3Rs, i.e. Reduction, Refinement and Replacement which was

first articulated by William Russell and Rex Burch in a book, Principles of Humane Experimental Technique. [5] In simple words, reduction implies that the lowest number of animals that can give a scientifically and statistically relevant result should be used. Refinement means ensuring that the animal suffers minimal hindrance or pain and replacement entails that wherever possible an animal experiment must always be replaced by an alternative that does not require animals like use of cell-culture lines, computer-based simulation devices, etc.

The way forward: using technology

The recent thrust in teaching methods of undergraduate experimental physiology resonates with the spirit of the 3Rs, especially with “Replacement”. The emphasis is increasingly on the use of computer-assisted, software based simulation teaching modules. The Medical Council of India in successive directions on the curriculum has held that amphibian experiments on nerve-muscle and cardiovascular physiology in MBBS practical physiology curriculum be conducted with computerized learning modules. [6-8] The Ministry of Environment and Forest, Government of India, also passed an order in the same spirit on January, 2012 where it was mentioned that unnecessary pain or suffering to the animal should be avoided during or after the performance of experiments on animals. Effective alternatives in the form of CD’s, computer simulations, manikin models, etc should be used in teaching Anatomy/Physiology. [9] The latest radical modifications done by the Medical Council of India in form of the introduction of Competency Based Undergraduate Curriculum in 2018 which are to be implemented from next academic session also emphasizes the use of computer-assisted learning for amphibian experiments. [10]

Advancement in technology has been at the core of the new teaching-learning methods being adopted worldwide. Since the 1990s, the widespread use of

computers and the tremendous development in the software have led to the evolution of the concepts of e-learning and using digital methods of imparting education like computer-based modules. These new methods have actually been found to result in a demonstrable improvement in learning in general. Studies on children [11] and in medical-surgical nursing students suggest that these methods produced better acquisition and retention of knowledge. [12]

What is computer-assisted learning?

A computer model, computer simulation or computational model is basically a computer program that attempts to simulate or artificially reproduce an abstract model of a particular system. These software programs are intended to imitate the actual experimental set up in laboratory and with all its component methods like anaesthesia, dissection, mounting of tissues, setting of electrical circuits as required as well as application of drugs or chemicals. They provide the experience of a virtual lab. Some of the common ones in practice are Virtual Physiology Series, Digital Frog, SimBioSys Physiology Labs, Reed Elsevier Animal Simulator, etc. [13] Majority of the CAL software packages also includes self-assessment tools such as multiple choice questions.

Pros and cons of Computer-Assisted Learning methods

Computer-Assisted Learning methods address all the concerns raised over the use of live amphibians in practical physiology curriculum. It is effective, saves time, avoids the wastage of energy and efforts in maintenance and handling of animals and also doesn’t violate the ethical and moral norms. It can be made available easily in the form of a CD-ROM. However, the best aspect of it is that the interactive interface makes the learning process student-centric [14,15] by actively involving them, both by generating curiosity and the ease of observing. Different parameters can be tested at the click of a mouse. The stimuli can be varied at will and the consequent effect easily observed on a screen. The

biggest advantage however is that the experiments can be repeated any number of times to the satisfaction of comprehension. In this way, it gives the scope that the learning experience be moulded and personalized as per understanding ability and pace of learning of an individual. The resultant of all these advantages is that resources as well as energy and time of the faculty are saved which can enhance proficiency in other spheres of activity. [16]

The only downside of it is that technology is an ever-evolving tool. Rapid advancements in the software packages could render older versions inoperable even though the content might be same. [17] So, we have to keep pace with this time-to-time upgradations.

Summary of findings of relevant studies

Studies available in the research literature comparing the traditional and computer-based learning methods on undergraduate students suggest a clear positive impact of the latter.

In a research work by Arora R et al to assess the perspectives of undergraduate medical students on the animal experiments in MBBS curriculum, 84% of the participants felt that these experiments inflicted “needless pain and suffering” to the animals. And nearly three-fourths of the participants believed that interactive computer programs, video films etc can be employed as alternative methods to animal experiments in practical physiology curriculum. [13]

Thaman RG et al in their study about student perceptions on use of computer assisted learning (CAL) vis-à-vis traditional methods found that most of the students agreed that “it can replace animal experiments as most of the learning objectives are met”, and “they provide better alternative to animal experiments”. They also observed that students found CAL as more student-centric as it “enabled the teacher to spend more time with the students” and “students could control their pace of learning”. The students were also divided into two groups for comparative assessment of the knowledge. The test

scores of second group which received computer assisted learning (CAL) were better than the first and there were statistically significant differences in the marks obtained. [2]

Doijad VP et al in their study compared live experimentation and video demonstration as learning aid in experimental physiology in first year MBBS students. Although they did not find a significant difference in the marks of the students in the assessment after the test, but as far as the student feedback was concerned, a resounding majority (75% of the participants) perceived that computer assisted video demonstration was a better teaching-learning method than the former and they understood the topics better. [1]

Mukherjee S et al in a study to assess the effectiveness of animal simulator software as a teaching tool in amphibian physiology practical reported that there was a significantly high score of the students with the use of computer assisted learning as compared to the ones who received traditional teaching. They also evaluated its effectiveness among poor performers who were identified with a pre-test score of less than 50%. And they observed that there was no statistically significant difference in post-test scores of poor performers and good performers in the group that received computer assisted teaching. However, among those with the traditional teaching there was a significant difference between post-test scores of poor performers and good performers. This highlights that for slow learners, teaching with the aid of software-based modules was very effective. The comparative student perception on this matter weighed strongly in favour of computer-assisted learning modules. Most of the students agreed that “simulation is a better alternative to traditional lecture demonstration”, “steps of dissection of frog is better visualized in simulation technique”, “electrical circuits and technical details of the experiment is better depicted by simulation technique” and “simulation programme is student-centred”. Most of the

students disagreed that “handling of software is difficult and time-consuming”. This is probably because children nowadays are exposed to technology at a relatively early age through mobile phones and video games. [18]

Rochelle ABFA et al conducted a study to assess the perception of undergraduate students studying in allied medical courses like dentistry and pharmacy about the use of animals in practical classes. Around three-fourth of the students experienced some form of difficulty in experiments with animals. And nearly half of the students were of the view that use of animals in practical classes should be replaced by suitable alternative methods. [19]

Bhattacharya SN et al in their study demonstrated that there was a statistically significant difference between the pre and post-test scores in both male and female students. They also observed that there was an improvement in the minimum scores in both males and females after the exercise. [20]

Various authors have also reported that a considerable number of students experience moral uneasiness [21] (Arluke A et al) and negative reactions (Bennett J) while performing experiments on animals. [22]

CONCLUSION

There is a belief that the art of clinical medicine cannot be taught or learnt without exposure to wards, emphasizing the role of a direct hands-on experience. However to draw a parallel to this with physiology and amphibian experiments would not be prudent. It is difficult to comprehend the utility of the skills of stunning or pithing for example for a future medical graduate. This analogy thus is quite debatable. Any change is always met with resistance. One of the key issues in implementation of computer-based learning is its acceptability among the faculties. [23] There is an air of apprehension and often many people are less inclined to use electronic or digital teaching methods. But,

taking into account the well-established positive impact of these new methods among the students, it is time we react to the need of the hour with open minds.

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