

Opinion Article

Animal experiments in physiology education

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Received : 28 March 2020

Accepted : 09 August 2020

Published : 25 January 2021

DOI

10.25259/IJPP_265_2020

Quick Response Code:



INTRODUCTION

Animals are biologically similar to humans in various ways. Thus, it is believed that animal studies provide us the platform to understand the stages of a normal biological process or the course of a disease that allow students and researchers to determine the underlying events in a systems-wise manner. In India, the use of animals in teaching physiology at undergraduate and postgraduate levels has remained controversial since the turn of this century creating an unfortunate hostile environment due to polarised views. There is, however, a need to reflect on and critically assess whether the current educational format virtually without any meaningful exposure to real animal experiments indeed ensures Indian graduates in basic and medical sciences the opportunity to attain full appreciation of the complexities at all scales of physiological understanding.

AN OVERVIEW OF CURRENT SCENARIO

A global review on the use of animals in teaching of biomedical sciences reveals that teaching of animal physiology, pharmacology and behaviour continues with the use of live animals under a policy that involves respect for all forms of life and it is supplemented with videos, models and computer simulations. It is being acknowledged that such form of training (i) promotes biomedical scientists to develop their respect for living organisms, (ii) makes them sensitive to ethical issues and (iii) prepares them to contribute toward uplifting educated public opinion about living organisms and the environment.^[1] In the United States, live animal dissections and experimentations are used in primary and in secondary school education.^[2] The American Association for Laboratory Animal Science recognizes that 'the appropriate and humane use of animals in the elementary and secondary classrooms can provide significant educational benefits to the students and that a positive interaction between students and animals in the classroom enhances not only scientific learning but also provides an additional avenue promoting the development and growth of the students' sense of responsibility and respect for all living things.^[3] In universities, animals are used for teaching in a wide range of disciplines that include anatomy, anaesthesiology, biochemistry, pharmacology, physiology, zoology, surgery, neurosurgery and urology.^[4] In Europe, the research and development in basic biological science, medicine, veterinary and dentistry make significant degree of animal use.^[5] In India, however, teaching of biology, life sciences and medical sciences offer a totally contrasting scenario from what we find in the western countries. The use of animals in undergraduate and postgraduate teaching of zoology and life sciences has ceased following the ban issued in 2014 by the University Grants Commission, a statutory body set up by the Indian Union Government and charged with the coordination, determination and maintenance of standards of higher education in India.^[6] The Medical Council of India (MCI) which overlooks medical education in most of the public

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and private medical colleges has imposed a ban on animal dissection in undergraduate medical courses in 2014.^[7] In a gazette notification (No. MCI-34(41)/2013-Med./64022 clause A.1.9), MCI recommended for the use of computer-assisted modules for teaching Physiology and Pharmacology in UG curriculum.^[8] However, in 2019, the MCI has allowed animal experimentations in postgraduate physiology teaching within its competency based medical education program.^[9]

LEARNERS' PERSPECTIVES

Since the 1980's with resurgence of animal activism, there has been a steady decline in animal laboratory exercises for teaching of physiology with more use of technology that allows the demonstration of physiological phenomena through computer simulations. Raanan in 2005 reviewed the scenario and suggested a few reasons that may favour computer aided learning modules over live animal experiments, which include cost factor, development of computer simulations, changes in medical education programs, high level of technical expertise required and pressure created by anti-vivisectionists.^[10] Hansen and Boss, however, emphasised that 'there is no substitute for the educational experience of seeing and touching living tissue while manipulating physiologic or pharmacologic variables.'^[11] It was opined that students would be best served by a graduated set of exercises: "The most effective way to help students understand physiological interactions on a systemic basis is to first use technological approaches to proceed from simple to more complex models and then to test hypotheses based on model behaviour in an investigative experience with a living preparation."^[12] It is understandable that interactive computer simulations are very useful and have been widely adopted for various reasons, but they cannot be a complete educational replacement for animal laboratories which provide opportunities to integrate an understanding of complex physiological concepts above and beyond what simulations can offer.^[11]

Active learning is considered to be the way forward in a student-centric approach in education.^[13] The active learning in animal laboratory exercises conducted in physiology allows students to engagement and development of critical thinking skills. Active learning encourages students to design and carry out experiments, to observe physiological phenomenon and make decisions about how to progress through the laboratory exercise based on their observations. Carroll^[14] considers that laboratory experiences help to develop hands-on skills which are complementary to active learning approaches in medical education. Such views are reinforced by studies that have been conducted in India wherein 1st year undergraduate students compared traditional animal experiments with computer-based simulations for their learning needs.^[15,16]

A recent innovation in education now involves the combination of online virtual experiment using computer-assisted techniques conducted before actual live animal experiments that are conducted by students or as lecture-demonstrations which permit proper training of the theoretical concepts that help to build up the confidence with the experimental techniques before the hands on laboratory exercise. Quiroga and Choate^[17] designed and developed for students a virtual experiment to complete before an inquiry-based 'live' practical of how autonomic nerves control contractions in the isolated rabbit ileum. It was observed that most students who had engaged themselves with the virtual experiment could better understand the practical physiological concepts and experimental design, as well as, with the self-reported time spent on the virtual experiment (and not on lectures or practical class notes), as an useful predictor of their understanding. This novel finding provides evidence that virtual experiments can contribute to students' research skills development.^[17,18] The use of virtual experiments and computer-based simulations has been found to provide a way of reducing the 'noise' in students experience in the practical class environment by pre-familiarising them with the ideas and concepts underlying the experiment, the apparatus and materials, the planning and sequence of actions and the expected results.

Recently, Durand *et al.*^[19] conducted a study on three groups of medical students who undertook either live animal experiment/demonstration or virtual laboratory activity through the use of video and computer assisted learning or both, in conjunction with a problem based learning session report. On the basis of students' perception, they concluded that such tools can reinforce skills in animal handling, manipulation and laboratory skills, on the one hand, while reinforcing skills in graph software manipulation, data analysis and information technology skills.^[19] In fact, most students preferred such blended style as the ideal teaching method for experiments supporting the authors' conclusion that the virtual laboratory serves as an effective preparation tool, and the blended laboratories may soon become the generally acknowledged best laboratory teaching practice in physiology.^[20] Furthermore, not all students need to have skill of animal handling and dissection;^[21] however, performing the animal experiments nevertheless are an invaluable strategy toward engaging the students in the process of science education.^[21-23] The lessons gathered through animal experimentation cannot be met by alternative tasks with added scores of realism and authenticity as students realise that knowledge creation is a dynamic process.

STUDENTS' MOTIVATION AND LEARNING EFFICACY

In a study aimed to gauge student motivation to animal experiments to study physiology, Dohn *et al.*^[24] examined

in the 2nd year undergraduate students their motivation by assessing students' levels of interest, willingness to engage (effort) and confidence in understanding (self-efficacy). Almost all students reported that laboratory work was very important for learning difficult concepts and physiological processes, as the hands-on experiences gave a more concrete idea of the learning content and made the content easier to remember. A significant correlation was found in self-efficacy in laboratory work and academic performance at the final exam. Students undertaking virtual dissection performed better in immediate post-testing, but did not demonstrate improved retention.^[25] The results of this study further indicated that the virtual animal provides a viable alternative to reducing physical dissection yielding effective learning outcomes and may be appealing to teachers and students for a number of practical and ethical reasons.

TEACHERS' RESPONSIBILITY

In view of the fact that administration of strategically blended course using animal experiments in a regulated and restricted way along with virtual animal-based and computer-assisted interactive learning at undergraduate and postgraduate levels is the way forward for physiology education in the future, teachers have specific responsibilities of developing courses and contents congruent to the above-mentioned blending method of teaching-learning of physiology while translating the new strategy into action. In addition, undergraduate and postgraduate students of physiology must be sufficiently exposed to the practise of good animal ethics including legal, administrative, ethical, statistical and technical aspects of animal experimentation, which is of great use for those who may opt for career options as researchers in wildlife management and as medical researchers.^[26] Teachers need to engage the students deeply with the ethical questions that underlie use and dissection of animals and consider how its learning outcomes can be achieved through humane science education practices.^[27] Teaching physiological science at all levels needs to be inquiry-based focussing on 'the need for students to experience the process of science to view science as a way of knowing, rather than a body of knowledge.'^[28]

Declaration of patient consent

Patient's consent not required as there are no patients in this study.

Financial support and sponsorship

Nil.

Conflicts of interest

There are no conflicts of interest.

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How to cite this article: Ghosh D, Sengupta J. Animal experiments in physiology education. *Indian J Physiol Pharmacol* 2020;64(Suppl_1):S28-S31.