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A study on Alternatives to the Use of Animals in Teaching of Animal Science Courses

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ABSTRACT

Animal science, as a branch of biology that studies animals, is a fascinating subject that requires hands-on experience with live animals for better understanding. However, the use of live animals in teaching became controversial due to ethical, legal, environmental and practical reasons leading to ban on use of animals for education purpose in various countries. Various alternatives emerged to fill this gap by replacing the use of animals in teaching of animal science courses. In this study, the alternatives to the use of animals and their effectiveness in enhancing student's learning in absence of live animals in animal science courses will be studied. Also, various issues and concerns related to use of alternatives in the teaching of animal science courses in providing adequate replacement to the use of animals will be examined. Our findings suggest that various alternatives are providing effective replacement to the use of live animals in teaching of animal science courses. Their effectiveness depends on several factors such as their quality, engagement of student, their benefit over traditional dissection practices, mindset of the educators etc. Some issues and concerns identified in implementation of alternatives were the lack of adequate alternatives according to course requirement, difficulty in procuring alternatives due to their high cost and insufficient funding, teachers' reluctance and awareness, limitations of alternatives, technical/ technological issues faced during their implementation, difficulty faced by teachers in locating suitable resources etc. There is requirement of proper funding and institutional support to implement suitable alternatives and to increase awareness among teachers regarding the availability of suitable and affordable alternatives by conducting meetings and workshops on alternative approaches.

Keywords: alternatives, animals, teaching, animal science courses

INTRODUCTION

Animal science is a subject which conducts scientific study of animals. Teaching animal science courses has traditionally relied on the use of live animals to provide students with hands-on experience and a deeper understanding of animal behavior and physiology. Live animals have been widely used in animal science practicals in education field as far as time goes back. However, the use of live animals in teaching has raised concerns about animal welfare, ethical considerations, environmental impact and practical issues such as availability, cost, and safety of animals (Dewhurst & Kojic, 2011). One of the major concerns associated with the use of live animals in teaching is their potential impact on animal welfare. Animals being sentient beings deserve moral and ethical consideration from humans (Ladwig, 2023). They should not be used as means to a goal, and should not be unnecessarily exploited for human gain. Picking animals from natural environment for education or research purpose may disrupt food web including that particular animal and due to interdependency of various animals on each other (Calizza, Costantini & Rossi, 2015) may cause adverse impact on environment. Excessive use of few varieties of animals for various human use may cause these animals or the animals dependent on these animals for food to be endangered or extinct. Many animals are bred in laboratory for education and research purpose which have its own moral and ethical dilemma. Animals bred in laboratory are not kept in humane condition causing them stress. This stress is inevitable and is brought on by a variety of factors, including imprisonment, transportation, restraint, noise and other processes involved in handling of the animals, as well as the experimental methods used on the animals (Balcombe, Barnard & Sandusky, 2004; Bailey, 2018). The use of live animals for teaching purpose can cause suffering, stress, injury, lifelong harm or even death to the animals, and can also perpetuate the belief that animals are disposable objects for human. It is also inhumane practice. The fact that laboratory animals undergo considerable and recurrent stress is widely acknowledged (Bailey, 2018). Advancement in technology has provided scope for humane education. Using digital alternatives have proved to have equal or more effectiveness than live animals and allow students to repeat the virtual dissection with no additional instructional cost (Lalley et al., 2010) or harm to animals. Animal ethics is equally important as the human welfare.

Due to these concerns, many governments around the world have banned the use of live animals for the teaching purpose in various disciplines including the field of biological sciences. Now, the goal of laboratory curricula is to foster in students a sense of responsibility for the welfare of animals as well as an appreciation and respect for life (Pokale, 2019). Educators and students do not prefer hands-on dissection due to variety of reasons like ethical, moral, and physiological reasons (Elmali, 2022). Only researchers are allowed to use animals in scientific researches but only if they follow stipulated ethical protocols regarding the use of animals for study purpose. Currently, all over the developed world, ethical regulations are in the place to govern the use of animals in education and research. Due to these reasons, many alternative approaches emerged to replace the use of live animals in teaching of Animal Science courses and to improve the quality of science education (Pokale, 2017). Some of these alternatives are plastic modals, videos, preserved specimen etc. while other advanced alternatives include use of computer-based alternatives. We are now at a point where we can evaluate a wide range of alternatives to using animals in education and training due to the growth of technology (Cheluvappa, Scowen & Eri, 2017). However, their effectiveness in enhancing student learning of animal science and their potential impact on animal welfare are not well understood. In this paper, the different alternative approaches in the teaching of animal science without live animals has been studied.

The aim of this research paper is to study the alternatives to the use of animals in teaching of Animal Science courses. Following are the main objectives of this study:

a) To study about the alternatives to the use of animals in teaching of animal science courses.

b) To study about the effectiveness of alternatives of animals in teaching of animal science courses.

c) To study the issues and concerns of the alternatives of animals in teaching of animal science courses.

METHODOLOGY OF THE STUDY

This study aims to examine the alternatives to the use of animals in teaching of Animal Science courses and their different aspects like their effectiveness and issues and concerns in their implementation to gain a holistic understanding of it. Papers were searched on databases like ResearchGate, google scholar, springer, PubMed Central (PMC) etc. and related research articles were identified. The research articles containing information about available alternatives, researches supporting their effectiveness and studying the issues and concerns in their implementation in animal science education were reviewed and summarized. The majority of the included articles were from foreign countries. This literature review's primary purpose is to provide more precise understanding of the alternatives to the use of animals in Animal Science courses. Based on the results, the literature reviews provided recommendations for the practice of alternatives of the animals in animal science education.

Study of the alternatives to the use of animals in teaching of Animal Science courses

When ban on the use of animals in education field was imposed by the UGC, it recommended replacing manual animal dissection with digital replacements like ProDissector Frog, BioLab Frog, and DigiFrog (Ammanna, 2018; UGC 2014). Nowadays, variety of alternatives are available which has changed the landscape of animal science teaching by changing the nature of its lab from live animals as experimental subjects to alternatives like charts, models and preserved specimen, anatomical atlas, audiovisual aids, CAL, virtual zoo, virtual labs, virtual dissection softwares/applications and simulation softwares, three-dimensional(3D) anatomical atlas, 3D anatomy software, Virtual reality(VR), Augmented reality(AR), Mixed reality(MR), internet-based platforms hosting physiology simulations and virtual experiments, BIO-VR etc. In recent years, internet-based platforms have emerged as one of the main alternative approaches for teaching animal science without live animals. These online platforms are not only better than all other alternatives currently available regarding use of live animals in technology but they also provide several advantages over traditional laboratory using hands on dissection processes.

Websites like InterNICHE, PETA, and others have listed a number of these alternatives in an effort to raise awareness of them. InterNICHE, an international network for humane education supports students' freedom of conscience and progressive science instruction by collaborating with educators to propose alternatives to animal experimentation. In order to satisfy the demands of educators and trainers, students, ethics committees, alternative producers, and activists worldwide, this online platform includes a growing collection of material, database access, and downloads pertaining to alternatives of using animals in education in several languages. It offers a comprehensive database of substitutes for animals categorized by discipline and educational attainment from other nations in a range of formats such as modals, mannikins, simulators, software, video etc. It features loan programs that provide alternatives based on the learning objectives of practical classroom that call for the usage of animals. Some options provided by Indian enterprises on this database includes animal simulator, Froggipedia, and Compuseries.

There are several other such online platforms available to provide information regarding alternatives. A website www.onlinelabs.in/biology provides a list of freely available biology lab resources. It contains list of free digital labs for various educational level and for variety of topics which includes anatomy, physiology as well as dissection. Digital dissection kit for variety of animals like pig, cat, frog etc are made available here from reputed universities of the world. For more hands-on laboratory experience, there are options for paid lab resources too. A Norwegian Inventory of Alternatives, or NORINA, is an English-language resource that offers details on supplements or substitutes for using animals in training and education at all educational levels, from school to

university. Since its establishment in 1991, this database has undergone continuous updates. Although it is a database designed according to curriculum of the country Norway, it can be useful for other countries also like India.

Various companies have started making virtual biology dissection kits which are available in market for schools and universities according to the need of students for a cost price for e.g. Immersive Labz, an Indian startup company is providing paid innovative learning products called SimuLab (A 3D Virtual Science Lab) and Cadaviz (Virtual Human Dissection Table) for higher secondary biology classrooms revolutionizing practical science education in Indian classroom.

Study of the effectiveness of alternatives of animals in teaching of Animal Science courses:

Alternative approaches offer several advantages over traditional methods of teaching animal science that involves hands-on dissection activity on live animals including flexibility, accessibility, and cost-effectiveness. For example, charts, models and preserved specimen can effectively teach many concepts without causing harm to a life. Other alternative approaches like various digital software and internet-based platforms can provide a safe and controlled environment for students to observe and interact with virtual animals without the risks associated with handling live animal. Digital alternatives are better than other alternatives for live animals in animal science because they provide wholesome experience and are more engaging and interactive than simple alternatives like modals or videos. They can also provide a more accessible and flexible learning experience for students who may not have access to live animals due to geographic, financial, or other constraints (Ahmed, Chowdhury & Mozumder, 2023; Diwakar et al., 2016; Gaganis et al., 2021). Furthermore, they can be used to simulate complex animal physiological processes that may be difficult or impossible to observe in live animals. Moreover, breeding of animals and their care and handling proves to be more expensive in longer term than digital or any other alternatives. Digital alternatives are less expensive than dissection, last for years, and may be used simultaneously by several student groups during each academic year. By using digital alternatives instead of live animals, Students can simply take the lessons at their own pace, catch up on missed classes and do dissection exercises again and again until they develop understanding of the material (Ammanna, 2018; Gaganis et al., 2021).

Several studies have investigated the effectiveness of alternatives in enhancing students understanding of animal science. Zemanova & Knight (2021) in his study found that using humane teaching approaches yields better or equal learning outcomes to using animals for same purpose. A 3D anatomical atlas can be used to study the anatomical features of animals (Park, Kim & Shin, 2019). Internet-based platforms and digital alternatives are also very effective in enhancing student learning in animal science. Computer Assisted Learning (CAL) enhances the learning experience of the students gives students a platform to develop a nearly accurate understanding of actual experimentation and thus fills the gap between isolated animal experimentation and didactic demonstration classes (Babu, Singh & Palla, 2015; Sharma et al., 2017). They are designed to cover the major objectives of the experiments and can actively involve large number of students simultaneously (Thaman et al., 2012).

Virtual dissection is an effective alternative to real dissection (Apat, 2019). Virtual labs improve Students' conceptual comprehension, laboratory or practical abilities, motivation and attitudes toward biology (Celine, Nsanganwimana & Tarmo, 2022). Virtual learning in case of laboratory animal dissection provides the students in-depth knowledge of animal anatomy and physiology through virtual manipulations and offers many advantages over conventional dissection techniques, including repeatability, immediate feedback, freedom of time, place, and value (Meena, 2020; Quiroga & choate, 2019; Azizah & Aloysius, 2020). Virtual dissection is especially very useful for topics requiring dissection of higher vertebrates or humans (Havlickova, Sorgo & Bilek, 2018). Online labs serve as interactive textbooks that encourage student participation and have favorable learning correlations (Diwakar et al., 2016). An online platform that provides interactive 3D models of animal anatomy can improve students' spatial reasoning skills and their ability to visualize complex anatomical structures. Software like Virtual Zoo has developed 3D animal objects with virtual surroundings using animations

and videos from the real environment including the voices and scientific description of variety of animals available in traditional zoos (Ahmed & Hossain, 2020). Online platforms like Simulabs and Animal stimulator that simulates animal behavior and physiology can enhance students' understanding of animal biology and increase their engagement in the learning process.

Study of the issues and concerns of the use of alternatives of animals in teaching of Animal Science courses

Even after availability of so many new alternatives, statistical reports of number of animals used for educational and training purposes of many developed countries show that animals are still being used for education purpose (Zemanova & Knight, 2021). Besides these, many studies support online or digital alternatives only as complementary lab activity along with hands-on dissection laboratory on animals. Whitworth et al., (2018) in their study found that using hands-on laboratory curriculum along with computer simulation of the same experiment improved conceptual understanding. Ghosh & Sengupta (2021) have advocated for blended teaching learning of physiology. According to them, the way forward for physiology education in the future is through carefully integrated courses that include animal-based virtual learning and computer-assisted interactive learning at undergraduate and postgraduate levels. According to Wang, Liu & Ma (2018), virtual laboratories are effective for animal science practicals but the blended laboratories has proved to be the best laboratory teaching practice. He also stated that the design of the software for the virtual laboratory needs improvement. When comparing a digital alternative frogout for frog dissection to actual dissection, Fabonan et al., (2022) found actual dissection to be preferable to Froguts as it provides sensory experience and clear exploration of the subject. There are various issues and concerns regarding the alternative approaches which may impact their effectiveness or implementation and leading to preference of dissection or hybrid laboratory over complete replacement of animals by alternatives. Alternative approaches have several limitations that can affect their effectiveness in teaching-learning of animal science courses. Some of the issues identified are discussed below:

Limitations of alternatives

Alternative approaches may lack the tactile and sensory experiences associated with live animal handling, which can limit students' understanding of animal behavior and physiology (Babu, Singh & Palla, 2015; Dohn et al., 2016). They may also be limited in their ability to provide hands on approach to handling animals or developing fine motor skills which provide a comprehensive understanding of animal species for study, which can limit students' exposure and understanding regarding animal study. In a study conducted by Babu, Singh & Palla (2015), students pointed out lack of contact with living tissues and animals as the main drawback of CAL software. Many alternatives have their own limitations. Azer & Azer (2016) found no evidence that the use of 3D models was better than traditional teaching. A 3D anatomical atlas can only help with the quick identification of anatomical features; it is not very useful for gaining in-depth anatomical information or remembering the locations of anatomical structures (Park, Kim & Shin, 2019). Online laboratories can successfully replace traditional prosection laboratories and enhance interactions but they are not the same as face-to-face laboratories (Attardi, Barbeau & Rogers, 2018). Because of the complexity of the biological reactions, it is difficult to simulate actual animal experiments accurately (Badyal & Desai, 2014). As a result, the outcomes produced by simulated alternative models may not be entirely accurate.

Technical/ technological issues

Additionally, alternative approaches like digital alternatives may require specialized technical skills and resources that may not be available to all educators and students. Setting up the alternatives and instructing students in dissection techniques to study anatomical structure frequently wastes time (De Villiers & Monk, 2005) when mastering the technical expertise is not even the final objective. Internet connectivity is also a factor here. Apat (2019) found that the students preferred physical animal

dissection not only due to the real, richer experiences and data that traditional dissection offers, but also due to technical/technological issues and other drawbacks that learner faced while using alternatives.

Cost of alternatives and Funding

Implementation of alternatives in any institution requires funding and institutional support to implement them in educational institution. Cost is the biggest barrier to implementing alternatives in many institutions (Osenkowski, Karaliunas & Diorio; 2022). Due to insufficient fundings, many institutions are not able to afford technical and infrastructural support required to establish digital alternatives in their schools/universities.

Difficulty in locating the resources

Alternative approaches need to be carefully selected according to the requirement of topics to achieve desired learning objectives. Educators face difficulty in finding those alternatives which not only aligns with educational requirement of the course but also is budget friendly and can be procured within limited institutional funding. Unavailability of resources in local languages is also a barrier.

Lack of adequate alternatives according to course requirement

Not all topics requiring animal models may be covered by alternatives for teaching of animal science. For some topics for e.g., skeletal systems can't be replaced by software-based virtual dissection in which students feel and understand the shapes and contours of the bones by touching them with own hands and learn how they differ from each other (Vartak, Rathod & Nath, 2019) thus for teaching them appropriate TLM like modals of bones should be used. Zemanova, Knight & Lybæk (2021) found one of the main reasons for continued use of animals for education purpose to be lack of adequate alternatives.

Teachers' reluctance and awareness

Awareness of teachers regarding ethical issues in using animals for teaching purpose in animal science education and their replacement is important. There are many databases available on internet to provide information about availability and use of alternatives but many teachers of animal science field are not aware about them (Osenkowski, 2015). Some teachers are aware about alternatives but resistant to the change to alternatives from traditional dissection practices and believes dissection to be the best way which fulfills hands-on biology learning objectives (King et al., 2004; Osenkowski, Karaliunas & Diorio, 2022). Zemanova, Knight & Lybæk (2021) in his study found educators reluctance to implement alternatives as one of the reasons for continued use of animals for education purpose. Educators considered use of animals for learning as "proper" learning because for them handling of animals is a part of the learning process.

CONCLUSION

Findings from this study suggests that effective alternatives to replace the use of live animals in teaching animal science courses are available but there are many barriers in their use. Their effectiveness depends on several factors such as the quality of the alternatives, the engagement of the students, teachers support and the level of student participation. Various concerns like lack of interaction with living tissues and animals, absence of hands-on learning, lack of coverage of certain topics with alternatives etc. are also barrier in implementation of alternatives. These are not more significant than seeing the long-term benefit of digital alternatives on animal welfare and promoting humane education and as we know the technology is constantly evolving, many more alternatives with further improvement will be developed in future. However, there are many areas which needs to be taken care for alternatives to be effectively implemented in teaching of animal science courses for instance issues and concerns like requirement of specialized technical skills and resources, lack of funding and institutional support for alternative setup, unavailability of resources in local languages, difficulty in locating resources, educators' reluctance and preference for the hands-on experience of

dissection, higher cost in implementing alternatives etc. needs to be taken care for proper implementation of alternatives. Addressing these issues and concerns should be prioritized for improvement in animal science education in light of ban on use of animals in teaching of animal science courses. Government should allocate sufficient funding for educational institutions to set up virtual labs, virtual simulation labs etc. and procure other suitable alternatives. There are also options of free alternatives made available by organizations working in the direction of animal welfare. There is misconception among educators that alternatives are costly however, there are variety of free and paid alternatives and biology lab resources in India and around the world which most of educators are not aware of. Online websites like InterNICHE, PETA etc. are working towards filling this knowledge gap and to increase awareness towards humane education. Increasing awareness about availability of variety of alternatives among teachers is very important. Teachers must be persuaded of the alternatives' viability and made more aware of the opportunities they present. Practical workshops on alternative methods should be organized in schools and universities to increase awareness and acceptability of alternatives for live animals in teaching of animal science. Many teachers are aware about digital alternatives but do not have idea of which alternative will be more suitable for achieving which objectives. Workshops may provide comprehensive information regarding these also. Workshops are useful for education, training and dissemination of information on the three Rs. There is also need for developing a catalogue providing information of digital alternatives and their outcomes i.e., which alternative will be useful to achieve which objectives of the course.

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