

REVIEW

Ethical and Effective Acquisition of Knowledge and Skills in Veterinary Education and Training

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InterNICHE

Abstract

There is a wide range of humane and innovative tools and approaches used in veterinary education and training. Such new methods have been developed by teachers and trainers for pedagogical, economic and ethical reasons. The aim is to create the best quality education, ideally supported by validation of the efficacy of particular tools and approaches, while ensuring that animals are not used harmfully and that respect for animal life is engendered within the student. Veterinary education and training has not always met, and still often does not meet, this essential criterion. In this paper, we review tools and approaches that can be used to enhance education and training and to ensure the humane treatment and care of animals that must be observed as the very ethos of the veterinary profession. A review of the resources offered by the International Network for Humane Education (InterNICHE) is also presented.

1. Veterinary education and alternatives

1.1 Introduction

An important element of the veterinarian's role will always be to protect animals—a parallel to the physician's imperative, *Primum non nocere* (First, do no harm). However, although many students are drawn to the veterinary profession by their compassion for living beings, some who are highly motivated to work in animal care may choose to avoid veterinary education because it may still involve the killing of animals for dissection and their use to demonstrate a variety of biological principles and teach practical clinical skills whilst alive. Not only can these uses of animals present a barrier to otherwise dedicated students but they are also contrary to the ethos of the profession. Advo-

cates of such harmful animal use have argued that it enables understanding of subjects such as anatomy and physiology and assists in the mastery of some clinical and surgical skills. However, there are other ways of fulfilling these aims and delivering a good scientific education that provides the student with the skills and knowledge required for the veterinary profession.

Moreover, scientific knowledge and clinical skills are not all that are required of veterinarians. As professionals, veterinarians must understand animal behaviour and appreciate all the aspects of pain and emotion that lead to animal distress. They must also be able to deal with animal guardians, often in difficult circumstances such as the loss of a loved companion animal. As future veterinarians,

they must also be prepared for the increased focus on animal ethics in society. Such challenges require a well-developed sense of compassion, which the harmful use of animals in veterinary education is unlikely to promote.

As well as helping to meet practical teaching objectives, alternatives to harmful animal use also ensure that students do not acquire undesirable attitudes towards animals, such as an indifference to animal life and/or a disrespectful attitude towards animals as patients. Furthermore, some necessary elements of veterinary education, such as training in patient care and understanding species-typical behaviour, are likely to be undermined if there is harmful use of animals in the students' training.

1.2 Definition and types of alternative

Many scientists and teachers are implementing the 3Rs (reduction, replacement and refinement of animal experiments), as defined by *Russell and Burch (1992)*, using alternative approaches that improve animal welfare while maintaining and enhancing scientific rigour. The 3Rs, however, are not directly appropriate for veterinary medical education because they are rooted in the use of laboratory animals for research and testing, not in knowledge and skills acquisition. The ideal replacement alternatives in education may be non-animal, but they may equally involve animals. For example, students need the experience of handling animal tissue and living animals, including learning to perform invasive surgery and other clinical procedures.

The definition of alternatives within life science education (*Jukes et al., 2003*) can therefore be made stricter than that of the 3Rs, so as to comprise only replacement alternatives, and can be broadened to include approaches that involve neutral or beneficial work with individual animals. Alternatives are humane educational aids and teaching approaches that can replace the harmful use of animals, including termination of life and euthanasia that does not stem from a medical situation. This definition is consistent with the underlying reason for working with and using animals in veterinary training, namely to produce professionals who have the knowledge and skills to care for animals and protect their well-being. The definition also reflects current possibilities and opportunities for replacement of harmful animal use in

teaching and training.

In veterinary medicine, the major alternatives to harmful animal use in teaching and training include: models, mannekins, and simulators; multi-media computer simulation, including virtual reality; ethically sourced animal cadavers and tissue; and clinical work with animal patients. Film, *in vitro* labs and field studies can also play a role in replacement. Many of these approaches are already used to some degree in multiple phases of veterinary and other life science education, having been developed by teachers and trainers themselves, and could replace the harmful animal use remaining in an institute if extended in scope (*Jukes et al., 2003*). It should also be noted that many 'alternative' tools and approaches are not in fact seen as 'alternative' by many of those developing and/or using them, but are considered the norm; they are at the forefront of practice that has been developed to improve education and training, and for reasons of fiscal responsibility—often at the most progressive universities and institutes.

The authors address in detail a range of tools and approaches that are in fact already in use in a growing proportion of veterinary education, and explore the degree to which they can enhance teaching through better meeting teaching objectives. A recent issue of the *JVME (Scalese et al., 2005)* provides an extended discussion of the educational advantages evident in the use of simulators, and provisional results from other on-going comparative studies confirm the pedagogical superiority of well-designed alternative tools. Individual models and suppliers for many of the aids are listed in *Jukes and Chiuiua (Jukes et al., 2003)*.

1.2.1 Models, mannekins, and simulators

These alternatives comprise synthetic training objects—designed to replicate or simulate organs, limbs, or whole animals—and apparatus for simulating physiological functions and for the teaching of clinical skills, including those required in critical care. Plastic models showing animals' internal structure are commonly used for teaching morphology; in orthopaedics, plastic bones are widely used to illustrate fractures. Real animal cadavers that are ethically sourced can be used in similar fashion, through being dissected and then preserved by embalming and by techniques such as plastination. Mannekins (or phantoms) are life-like representations of animals or humans, designed for



POP trainer (laparoscopy simulator) in use in Multimedia Room, 2nd InterNICHE Conference, Oslo (Norway), 2005.



Critical Care Jerry mannekin (with breath and heart sounds simulator) in use at InterNICHE Seminar and Training in Alternatives in Education, Kharkiv Medical University (Ukraine), 2005.

clinical skills training.

Within veterinary medicine, mannekins can facilitate training in handling, blood sampling, intubation, thoracentesis, and CPR techniques. For difficult procedures such as the urinary catheterisation of female dogs, anatomically correct mannekins can allow the student to follow the visual and tactile clues for the technique. Technically demanding procedures and those involving risk or stress to an animal can, therefore, be mastered by students without use of live animals, and critical care cases can be explored in advance. The computerised mannekins that are now becoming extensively available for human medical education (Scalese et al., 2005) are less common within veterinary

medicine, but the latest Critical Care Jerry canine mannekin (*Rescue Critters*. <www.rescuecritters.com>) integrates a digital heart and breath sounds simulator, as well as providing opportunities for practicing intubation, CPR, IV access, and other skills. The mannekins that are now available for human medical education, moreover, also provide excellent opportunities for the acquisition of clinical skills by veterinary students.

Simulators are tools for surgery, critical care, and some clinical skills practice. Simulators range from suture trainers and surgery training devices to computerised 'patients.' Simple and inexpensive simulators are often employed for simple skills acquisition—for example, psychomotor and other

skills, including eye–hand coordination, instrument handling, and suturing. Simulated skin, hollow organ and intestinal anastomosis simulators, microsurgical trainers, and others are made from specially prepared plastics or latex to simulate the relevant tissue or organs realistically. Like mannekins, such simulators can give students more freedom to practice at their own rate, to learn by trial and error, and to repeat procedures, without high cost to animals.

Human patient mannekins and simulators are used in many countries for training students and professionals in clinical skills and procedures, as well as in critical care (Modell et al., 2002). The most advanced of these mannekins have artificial skin, bones, organs, pulse, and artificial fluids simulating blood and bile; and can also give feedback to the students and trainers. ‘Drugs’ can be injected and the computer then creates the simulation of dose-dependent physiological responses. Student ‘doctors’ and other trainees can, therefore, experience many different ‘patient’ conditions and situations, and learn in an environment that involves no harm to animals. Computerised, such simulators can present real-time emergencies and allow for real-time monitoring of how successful the trainee is in his or her performance of critical care or surgery, and therefore ensure uniformity of training.

One mid-range surgery simulator, the Pulsating Organ Perfusion (POP) Trainer (Optimist. <www.optimist.at>), used for minimally invasive surgery training, can accommodate waste animal organs that are perfused and practiced on. The simulation can be used especially well for training in the management of bleeding. Students can train for as long as they want, with no animal being harmed. The experience of using the POP Trainer has been that trainees will often spend extra hours to further develop their skills.

An advanced simulator developed at the University of Arkansas (Aboud et al., 2004) employs perfusion of a human cadaver to offer a realistic alternative to live surgery. The veins and arteries are dynamically filled with coloured liquid by a specially designed pump. This also applies pulsating pressure which can be transmitted to the vessels and thereby reliably simulate the vascular tree, all within a closed system. Dissection and a range of surgical and microsurgical approaches such as vascular suturing, anastomosis, and repair, in-

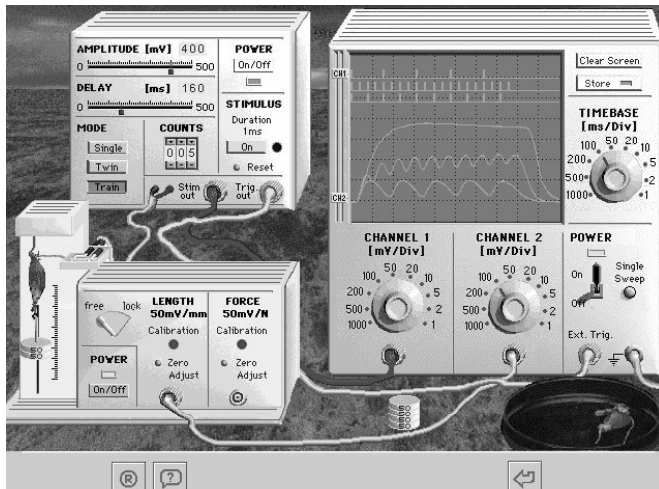
tra-parenchyma resection, bleeding management, and endoscopic procedures can all be performed. Realistic surgery can therefore be practiced and the technique potentially be applied to both human and animal cadavers. Used to their full potential, and as ever more sophisticated models become available, mannekins and simulators are allowing for considerable mastery of skills, not just exposure to them. By allowing repeated practice in an environment conducive to learning, the use of these specially designed tools can help students gain the necessary confidence and competence before working with patients. Aboud and colleagues (Aboud et al., 2004) have suggested that “utilising these techniques could forever eliminate the use of live anaesthetised animals for surgical training.”

1.2.2. Multimedia computer simulation

Computer technologies have revolutionised science and created many new opportunities for effective life science education. Examples include virtual dissections and experiments in well-equipped laboratories that students can perform on screen, and full virtual reality (VR) simulations of clinical technique, with tactile facilities. The potential of computer-assisted learning to help students better visualise and understand structure and process, experiment and learn problem-solving strategies, and even practice clinical skills is limited only by the power of the computer and our own imaginative boundaries. Papers recently published by the JVME (*e-Learning*, 2005) cover a variety of computer uses in veterinary education.

Well-designed educational software can encourage a high conceptual level of understanding as well as increase understanding of the specific topics being addressed. In particular, the software can encourage self-directed exploration and problem-solving strategies that support initiative, creativity, and scientific thinking. Such active learning is likely to be highly effective because it is firmly grounded in the student’s own experience. The innovative nature of new technological developments, such as multimedia software, can be exciting for students and teachers alike, which adds to the learning experience and is an important part of informal training for veterinarians for whom computer skills now play an important role.

Nevertheless, computer simulation should always be complemented by non-harmful practical experience with live animals, so that technology is



Screenshot from *Virtual Physiology Series* software for muscle physiology practical classes



ProDissector Frog anatomy software

kept as a powerful tool, not an alternative to reality. In a virtual dissection or anatomy program, students can perform tasks at their own pace, repeating as necessary. The range of facilities varies between programs. They may include libraries of colour photographic images, with gross anatomy and histology that can allow a comparison between species. The user can spin organs and highlight different organ systems, and physiological processes such as digestion can be presented through animations, 'morphing,' or video clips. Text information and opportunities for self-assessment may also be provided. These approaches, available on demand in the simulation, can provide a very rich and sensory experience to significantly enhance the quality and depth of learning. One anatomy program that uses modern technology very suc-

cessfully to enhance learning is ProDissector Frog (Schneider and Morse Group. <www.prodissector.com>). This innovative program offers the capability of controlling the opacity of organ systems within a composite layered image so that their spatial relationship can be effectively visualised. Tags label and describe all the relevant anatomical features. Future programs will include more species commonly used within veterinary medical education.

Multimedia software that includes a virtual laboratory presents a range of equipment on screen and may offer a very high degree of interactivity. Typically, such programs simulate classical animal preparations and experiments, with an emphasis on physiology, pharmacology, and critical care. These

disciplines lend themselves well to multimedia because of the need to correlate multiple and simultaneous events and to gain an understanding of the interplay between complex and related phenomena. Virtual laboratories provide practice-oriented tasks, building on students' theoretical knowledge, with students actively performing experiments themselves. Students do so by using simulated tissue responses to stimuli or pharmacological agents as they would in an animal practical or clinical scenario, while monitoring and recording data with on-screen oscilloscopes and other apparatus. This can be in real-time or adapted to requirements. Various parameters in the experiments can be modified by users to generate data sets for analysis, and there may be options for different levels of complexity within one program. The responses themselves may include random variables to simulate biological variability. Some simulations enable the illustration of concepts (e.g., the effects of breathing low oxygen concentrations) or the performance of tasks that would be unethical, difficult, or impossible in the real situation.

In the early 1990s, in response to students' conscientious objections, Braun and co-workers (Braun et al., 2003) created a Virtual Physiology Series of alternatives, from which it was apparent that rapidly developing computer techniques could provide an opportunity to make virtual laboratories where the students could do experiments in a manner analogous to that in a real laboratory. These programs can exactly reproduce the experiments previously done with real animal preparations. According to Braun (Braun et al., 2003), "It is my impression and that of other tutors that teaching has become not worse but more effective." Some good examples of such software are available from cLabs and from Thieme Publishers (cLabs.<www.clabs.de>, Thieme Publishers <www.thieme.com>).

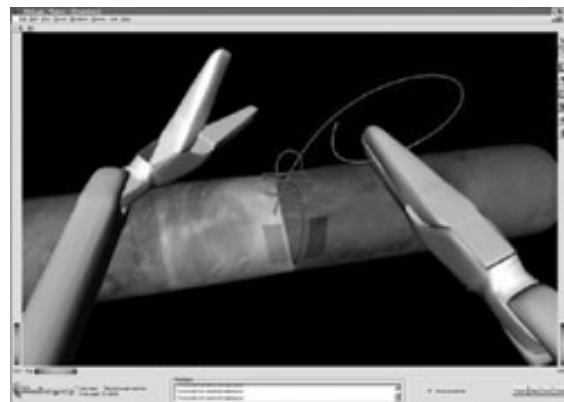
1.2.3. Virtual Reality

The term 'virtual reality' (VR) generally refers to advanced interactive software, with powerful 3-D graphics, that often immerses the user within the experience, allowing psychomotor skills and procedures to be practiced in a highly sensory manner. In this exciting and rapidly growing field, the use of new technologies dramatically increases the opportunities for real-time interaction with a dynamic model of reality, through the computer-human interface. One of the most advanced

uses of VR-based training is for flight simulations, due to the obvious practical and ethical limitations of real-life training; such simulations have become extremely important to the effective training of pilots. The adoption of VR approaches by the medical profession is driven by the same concerns about ensuring expert training and by the growth of innovative, minimally invasive diagnostic and therapeutic techniques well suited to VR simulation. Fear of litigation by patients who are unsatisfied or have been harmed through surgery has also influenced investment in VR in the US, in order to perfect training and thereby reduce risk.

Typically in VR, the trainee practices by holding a wand, which represents a needle, scalpel, or endoscope, and performs the required procedure on the virtual patient. The software images the anatomy and tracks the movement of the instrument in real time. As well as visual feedback, that of haptics, the tactile sense that can be simulated in VR, is playing an increasingly important role. Data gloves offer resistance, as the proxy instrument interacts with the virtual patient's body. This force feedback means that challenging techniques such as negotiating a needle around a vein or manoeuvring a catheter into the coronary arteries can be practiced and improved upon.

Most health sciences education VR so far has been used for skills enhancement for physicians, particularly to teach endovascular and endoscopic techniques. The approach has been applied less often within tertiary education, but VR within medical education is gaining in use. Computer scientists, in collaboration with a small number of veterinary colleges, have developed trial VR simu-



Virtual Reality surgery training using advanced *Sim-Surgery* software

lations for enhanced clinical skills acquisition and surgery practice. The University of Glasgow Veterinary School has been developing alternatives to invasive examinations on animals as part of its commitment to animal welfare and to ensuring better training for students. Its horse ovary palpation and haptic cow simulators (Baillie et al., 2005) allow students to practice palpation without risking harm to the animals, as well as providing a diversity of clinical cases to investigate. The system allows immediate feedback to the student, and unlike with a live animal, the instructor knows exactly what the student is feeling, and where, 'anatomically,' the student's fingers are in contact. As costs for VR decrease, projects at other colleges will no doubt be initiated in order to enhance veterinary training.

1.2.4 Ethically sourced animal cadavers and tissue

The study of anatomy in veterinary medicine would not be complete without hands-on work with animal cadavers and tissue. These resources are also excellent tools for clinical skills training and for the practice of surgical techniques, once basic competency has been gained using non-animal alternatives. Ethical alternatives to the use of killed animals for such cadaver requirements do exist—specifically, the use of ethically sourced animal cadavers and tissue. The term 'ethically sourced' refers only to cadavers and tissue obtained from animals that have died naturally or that have been euthanased in response to natural terminal disease or non-recoverable injury (Jukes et al., 2003).

Animals that have been harmed or killed to provide cadavers and tissue are not considered ethically sourced, nor are those sourced from places where harming or killing is commonplace. Furthermore, for the acquisition to be considered ethical, no market should be created or supported. The use of ethically sourced cadavers is standard practice in human medicine. Most medical schools have well established body donation programs, whereby, in their wills, individuals can donate their bodies for use by a specific medical school for student gross anatomy laboratories and dissections. The ethical sourcing of animal cadavers is potentially easier to implement than for human cadavers although in the former case the animal guardian is an essential intermediary. The most practical sources of animal cadavers are veterinary teaching

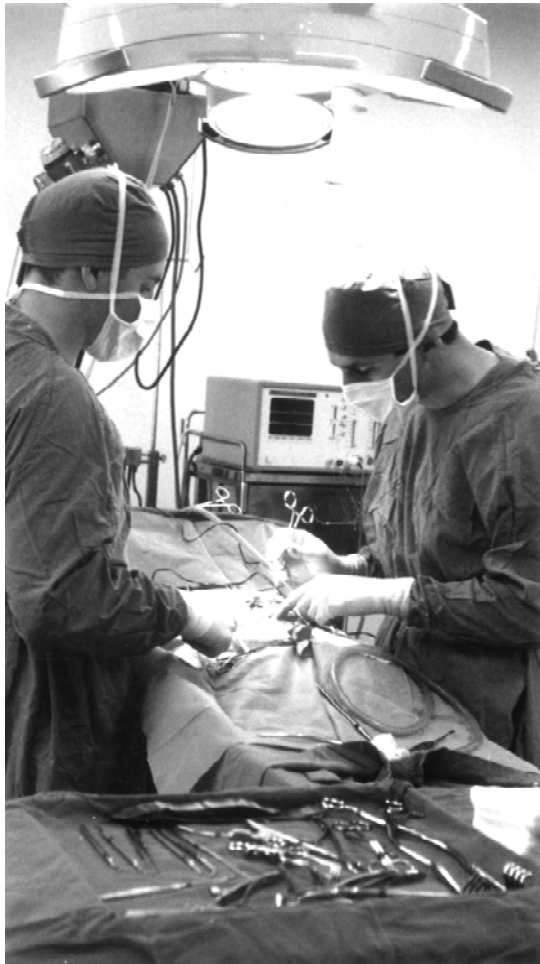
hospitals and independent veterinary clinics, typically through body donation programs. In these programs, clients of a clinic consent to donating the cadaver of their companion animal after the animal's natural death or euthanasia.

Body donation programs provide an excellent example of the multi-benefit solutions that the process of implementing alternatives can offer. Kumar (Kumar, 2003) reports that students appear to have a better appreciation of anatomy and exhibit more mature behaviour in taking care of cadavers with animals provided by a client donation program and that such a program is cost effective. According to Kumar (Kumar, 2003), "The cadaver needs of the first year gross anatomy course, as well as those of our clinical skills and medical procedure laboratories, are fully met. No healthy animal is sacrificed for the purpose of teaching." With increased co-operation between the departments of pathology, anatomy, and surgery, other possible sources of cadavers would include university pathology departments.

An important issue that needs to be addressed is that of the preservation and storage of cadavers. Cold storage within anatomy or pathology labs will keep cadavers in good condition and minimise autolysis, but re-use of cadavers and storage for future use require more than continuous storage in a cool room. Freezing cadavers is one solution, and careful preparation before freezing can help with the successful preservation of tissue and help ensure even thawing before use. Embalming fluids are also very often used to fix cadavers, as is the standard procedure with donated human body programs. Freeze-drying, silicone impregnation (silyphilisation), and a range of plastination techniques are increasingly being used for the preservation of cadavers, organs, and thin slices.

1.2.5 Clinical practice

The end goal of veterinary education is to provide new graduates with the clinical skills necessary to provide animals with optimum care. This clearly involves direct, hands-on care, including a range of invasive approaches to diagnosis and treatment. A primary issue is how to help newly admitted veterinary students, most often with few or no clinical skills, make the transition (often a multi-year process) and become professionals, competent in a breadth of procedures, without the well being of animals being compromised. In all primary veteri-



Student assisting veterinary surgeon in therapeutic operation on a dog

nary schools and colleges, the training of veterinary students involves direct experience with real patients and is undertaken as part of the provision of clinical care by faculty clinicians and private practitioners. This type of care is mostly directed to treating sick animals brought to the facilities by clients/animal guardians and providing for the animal's wellness by prophylactic treatments such as immunisation. Veterinary surgery training in Britain is humane by tradition, using the learning opportunities associated with clinical cases. However, in some colleges and some countries around the world, students still typically use laboratory animals for clinical skills and surgery training and do not have access to the learning opportunities associated with clinical work on patients. Such use of laboratory animals needs to be replaced by humane programs of education—for example, with

the student as part of the care giving team. For the veterinary student, work with living animals is essential, but the animals themselves should always benefit from the experience, or at least not be harmed.

Veterinary teaching hospitals and independent veterinary clinics have a constant flow of patients that can contribute to effective and rewarding student education by allowing a stepwise development from the observation of procedures, through student-assisted activities, to the performance of basic procedures by students. Essential professional abilities can be gained in this way, through experiencing and dealing with the clinical environment and its demands. It is essential that students learn how to work with animal patients, something likely best achieved through clinical work in clinical, problem-solving environments. Veterinary students can gain key clinical skills and surgical experience very effectively, and simultaneously, the animals benefit. Students can also gain an appreciation of the diversity of patients and clinical situations and improve skills in communicating with colleagues and animal guardians. To achieve this and to meet humane standards, several factors are paramount. First, the animal should not be harmed by the lack of experience of the novice student clinician, and it is, therefore, essential that the supervising clinician ensure that all experiences with and use of animals be either neutral or beneficial in their effect on the animals (Rasmussen, 2003). Neutral work with animals, involving routine maintenance, can provide key skills in animal handling. Involvement by students in clinical work with animals requires that they have the appropriate level of skills mastery. Students should be encouraged early to participate in non-harmful clinical skills training. As described in detail in prior sections of this paper, non-animal alternatives—such as models, mannekins, and simulators—can be powerful tools with which students can learn and acquire many clinical skills. Computer simulation can provide experience in anaesthesia management, critical care, and various procedures.

In accordance with Smeak, “[A]fter basic skills are mastered, cadavers from ethical sources are excellent aids for teaching tissue layers and exposure, surgical anatomy and basic closure methods. Finally students can then ‘graduate’ to treating live animals who are simultaneously patients receiving

beneficial treatment.” (Smeak, 2003) The use in some veterinary colleges of ‘clinic’ animals, kept and used repeatedly for training procedures, and the use of animals for experiments and terminal surgeries, work against the veterinary ethic of animal care and healing. As described within this paper, there are now a range of approaches that can be used to provide for the transition from new student to one with clinical competence, without the well-being of animals being compromised. It is to be expected that more and more such alternatives, with ever increasing sophistication, will rapidly become available. In Smeak’s opinion (Smeak., 2003), students can be better prepared for clinical surgery by using alternative teaching techniques. Other veterinary faculties could adopt such approaches within their curricula.

1.3 Reviews and assessment

Conventional animal experimentation has not been subject to the same scrutiny and demand for assessment as have modern teaching aids and approaches. Many teachers seem to continue animal practicals on the basis of tradition. When it comes to alternatives and humane education, however, the question of student performance is often central. A number of studies have been conducted to assess differences in learning performance as between conventional animal practicals and various alternative tools and approaches (Balcombe, 2003).

However, a simple comparison between the animal practical and the alternative is not always sufficient to fully investigate the potential and impact of alternatives. All curricular design involves combining tools from many different sources, and alternatives will almost always be used in combination to meet teaching objectives and to achieve a comprehensive learning experience. Nerve-muscle physiology practicals may combine computer simulation with student self-experimentation, and surgery courses may offer a range of different simulators in conjunction with clinical apprenticeship. To assess the learning experiences fully, it is often more appropriate to compare the use of a combination of tools with the animal practical, rather than the use of one tool in isolation. Moreover, a fully humane education will often involve careful design to meet additional important teaching objectives, like post-operative care in clinical courses or the problem-solving abilities encouraged through computer simulation.

A range of reports has suggested that the techniques described in this paper provide for good education and, as reported by Balcombe (Balcombe, 2003), over 30 studies have been published that suggest the alternatives to be equal or superior in terms of teaching efficacy when compared to conventional animal practicals. Below, we review briefly some of the evaluations of these methods, either as alternatives to the harmful use of animals or simply as good approaches to teaching.

Computer-aided instruction is gaining a strong foothold as an educational tool (*e-Learning*, 2005.). For example, Erickson and Clegg (1993) found that veterinary students rated computer-based active learning the best of several different methods for learning the basic cardiac curriculum and the interpretation of electrocardiographs. Block et al. (2002) reported that medical students found simulator models “to be superior to the animal model in teaching surgical airways and for management of pneumothorax.” Similarly, computer-based teaching aids typically performed equally well or better in physiology or pharmacology courses taken by medical students (Samsel et al., 1994), veterinary students (Fawver et al., 1990), nursing students (Phelps et al., 1992), pharmacology majors (Henman et al., 1983), and physiology undergraduates (Dewhurst et al., 1993, 1994). Dewhurst and Meehan (1993) have pointed out that the cost of the animal practical was five times greater than that of the computer simulation, and Fawver and colleagues (1990) found that the alternatives “saved faculty time.” A study by Samsel and colleagues (1994) found that the computer-based session for cardiovascular physiology teaching received a higher rating from students than did comparable animal demonstrations.

Regarding the acquisition of basic competency in clinical skills and surgery, a range of models has been assessed. Olsen and colleagues (1996) reported that a haemostasis model was as effective as live animals for teaching veterinary students the basic skills involved in blood-vessel ligation. Soft tissue models of canine abdominal organs developed at the University of Illinois were found to have handling properties comparable to those of actual organs and were useful for teaching a range of common surgical procedures (Greenfield et al., 1993). The DASIE (Dog Abdominal Surrogate for Instructional Exercises), developed at the Ontario

Veterinary College has also been a useful tool for teaching abdominal surgery at a number of institutes (Holmberg et al., 1994, 1993). In the case of human medicine, clinical procedures like endoscopy, often practiced using live animals as surrogate patients, can be taught using VR simulations. Simulations significantly improved practitioner performance (Rowe et al., 2000, Colt et al., 2001), and were superior to conventional training methods in the acquisition of procedural skills (Ost et al., 2001). Even the simplest of alternatives has been shown to meet the teaching objectives of basic skills acquisition: Packer and colleagues (Packer et al., 2001) reported that a videotaped demonstration could compete with a live animal demonstration, with either teaching method allowing students to develop a similar level of understanding of the principles behind the exercise.

Carpenter and colleagues (1991) reported no significant difference in the surgery performance of two groups of veterinary students, half trained using live animals and the other using cadaver surgery. Modern models can even offer a better education, as reported by Griffon and colleagues (2000), who drew the conclusion that the model used in their study was more effective than cadavers in teaching basic surgical skills and ovariohysterectomy in dogs. In another study, a comparison of the acquisition of surgical skills in veterinary students was undertaken, with students being randomly assigned to two groups—one where they learned with soft tissue plastic models, the other with anaesthetised dogs who were euthanised at the end of the practical (Greenfield et al., 1995). The students' surgical competence was then assessed during a spay surgery on a dog or cat from an animal shelter. Faculty members supervised these sessions and determined whether the students' cognitive and motor skills were sufficient. These spay surgeries were also videotaped, arranged in random order, and evaluated by eight surgeons from four veterinary schools. Students were re-evaluated a year later. The study showed no significant differences in the grades for the two groups. The researchers noted that this "makes a strong point that the students in the model training group were trained in surgery as well as or better than the students in the traditional training group." (Greenfield et al., 1995) They concluded by saying, "We believe that the models would have been an even more effective teaching tool if they had been available to students at times other than the labo-

ratory sessions, and if the procedures performed on the models were the same procedures subsequently performed on the live animals."

Another study of veterinary students who took an alternative small animal surgical procedure course at Tufts University (Balcombe, 2003) had their employers rate the students in surgical competency when they were hired and a year afterwards. No significant differences were found for any of the measures. This study is important because it assessed the learning experience by addressing the performance of procedures during employment. Assessment of alternatives by practitioners has also been conducted (Greenfield et al., 1993). Models of the canine spleen, kidney, and liver were made from soft plastic to simulate the organs of the live animal as closely as possible in appearance and tissue handling properties. Each organ model was independently evaluated by five small animal surgeons who performed several common surgical procedures on each model. It was concluded that all models had a realistic appearance and were useful for teaching each of the procedures evaluated (Greenfield et al., 1993).

2. InterNICHE resources and activity

The International Network for Humane Education (InterNICHE) is a global non-profit organisation and network with contacts in over 50 countries and a diverse range of resources, projects and achievements, all focusing on the implementation of best practice teaching approaches using alternative methods and the practical replacement of harmful animal use. This helps ensure ethical and effective acquisition of knowledge and skills in biological science, medical and veterinary medical education. InterNICHE aims to create sustainable change through presenting the vision of full replacement and focusing on practical ways in which the vision can be implemented on the ground, taking account of each situation's unique opportunities and challenges. This is done through the win-win approach, support for local initiatives, and provision of resources. Some of the resources and practical support made available to facilitate sustainable change are described below.

2.1 Information resources

Information resources are necessary for teachers and others to make informed choices regarding curricular change and the right combinations of alternatives for the location. The InterNICHE book

International Network for Humane Education

from guinea pig
to computer mouse



alternative methods for a progressive, humane education



InterNICHE

Nick Jukes
Mihnea Chiuta
Foreword by Gill Langley

Second edition, revised and expanded

from Guinea Pig to Computer Mouse (Jukes, 2003), now available in part in Japanese (*InterNICHE*, 2006, <www.interniche.org>), provides background information including studies of curricular design and assessment of alternatives, case studies written by university heads of department who have fully replaced harmful animal use, and links to many further resources. Full details of over 500 alternatives, including description, specification and source, comprise the bulk of the book, which is available in an increasing number of languages. The complete text of the book will soon be available on-line, including as a searchable and evolving database. On-line databases on alternatives are increasingly being specified as 'required visiting' before teachers and researchers apply to animal ethics committees, as part of the moral and legal burden of proof on teachers that they have investigated 'all possible alternatives' to animal procedures.

The InterNICHE website at www.interniche.org provides news and information about advances in life science education, arguments for the implementation of alternatives, student testimonies and advice on conscientious objection, and details of the resources that InterNICHE offers. It provides links to other organisations and their resources, and lists the latest contents of the Alternatives Loan System, with links to producers. Free to download is the 33-minute InterNICHE film *Alternatives in Education* (*InterNICHE*, 1999, <www.interniche.org/video.html>) which features interviews and demonstrations of alternatives by teachers, and the sound files (*InterNICHE*, 2005, <www.interniche.org/2005conference/online.html>) from the 2nd InterNICHE Conference held in Oslo in 2005. The site has an increasing number of visitors, and had over 2 million hits and over 100 GB of download in the 12 months to date. Translations of the site are available in a growing number of languages. It is also currently being redesigned to comprise many new facilities, in particular a large degree of interactivity and accessibility, and more on-line resources.

2.2 Support for conscientious objectors

Support for student conscientious objectors is crucially important in the face of some teachers' emotionally charged opposition to humane science, and the threat of academic or psychological penalty suffered by students. Information and practical advice on how to object responsibly, step-by-step, along with testimonies from student conscientious objectors, are provided at the InterNICHE website, and a growing number of students across the world are objecting to harmful animal use and calling for a modernised and progressive education. Some InterNICHE National Contacts are or have been conscientious objectors at the forefront of pushing for curricular change; co-author of this paper, Siri Martinsen, was the first in her country to graduate using alternatives only, and other students have graduated in the same way elsewhere. The role of conscientious objection in creating change is clearly illustrated by the example they have set within their discipline of what is possible, and by the alternative tools and approaches they may have helped implement for wider student access. The need for conscientious objection and the challenges facing such students when some teachers refuse to ex-

plore win-win solutions to ethical conflict illustrates the limits to students' freedom of conscience that are imposed within life science education by compulsory harmful animal use. The penalties sometimes imposed on critical thinking, ethically literate students who conscientiously object suggest that education is not as accessible as it should be. The life sciences need to decide whether a student's questioning of the orthodoxy, commitment to ethics and demand for educational best practice are more important than a teacher's attachment to convention. The latter have unlimited academic freedom to develop progressive humane ways of teaching.

2.3 Alternatives Loan System

InterNICHE built a large library of alternatives during 2001/2002 to support practically the process of replacement worldwide. This evolving Alternatives Loan System is co-ordinated from Slovenia, with alternatives available for free loan to all countries worldwide. Borrowers request items and sign a Borrowers Agreement Form guaranteeing that they will not copy software and will return the items when requested and in good condition. They pay only the return shipping costs. Over 100 CD-ROMs, videos, simulators and training mannekins are included for their pedagogical value and potential for replacement. The project has made over 200 loans to 40 countries, comprising over 4000 usages of individual alternatives, since its establishment. Borrowers include teachers, students, animal ethics committees, government ministries, organisations and campaigners. The loans have successfully given access to alternatives where none or little existed before, provided a resource for demonstrations at conferences, outreach tours and training, and supported the work of campaigners by providing a powerful international resource. As a tool for facilitating implementation, the value of the Loan System is indicated by a number of positive results: significant teacher use and the high number and wide geographical range of loans, positive feedback on the resource from borrowers, subsequent purchase and implementation of products, and direct replacement of harmful animal use (Jukes, 2006).

Small-scale 'micro-Loan Systems' have been established in Brazil, Russia, Ukraine, India and Japan, providing local resources under the management of National Contacts. These small libraries of alternatives facilitate ease of borrowing by avoid-

ing international shipping costs and by catering for particular cultural challenges and opportunities. These seed projects of the much larger international Loan System illustrate how much can be done with seed funding to support small-scale but highly effective and sustainable projects that are designed to facilitate replacement of harmful animal use. The establishment of new resources regionally and in different countries is to be encouraged.

2.4 Outreach and training

Outreach comprising individual presentations and seminars held at universities across the world can also be highly appreciated by teachers and students, particularly with visiting international speakers. Such widespread work has reached many new audiences. National Contacts may participate in or organise events or speaking tours across their country. Recent nationwide tours have taken place in Brazil, Russia, India and Japan, and typically also involve one-to-one meetings with university faculty. Display and demonstration of alternatives are also made at these events.

To maximise the impact of such visits, InterNICHE has organised a number of alternatives training seminars over the years to impart skills that will support effective implementation (Jukes, 2006). Such training comprises more than demonstrations of alternatives, and instead employs the expertise of local trainers who present in detail the content and potential of a range of alternatives, chosen according to the local curricula and situation. Alternatives from the Alternatives Loan System are typically used, and training may involve collaboration with producers.

In 2003, two Japanese students of veterinary medicine promoted and demonstrated alternatives in a tour that took them to the majority of Japan's 16 veterinary colleges. Items from the Loan System were used on this tour and at other seminars and conferences in Japan. In 2004, over 400 university teachers were trained in alternatives and animal welfare at a series of seminars in 10 cities across India, in a project organised by InterNICHE in conjunction with the World Society for the Protection of Animals (WSPA) and many committed individuals and local organisations from across the country. The project involved teams of teacher trainers, and was the first of its kind worldwide that has provided training at a national level to



European Commission ECVAM Conference *Alternatives to the Use of Animals in Higher Education*, Piran (Slovenia), 2002



Demonstrations to students at InterNICHE Seminar and Training in *Alternatives in Education*, Kharkiv Medical University (Ukraine), 2005.

such a large number of delegates.

The Multimedia Exhibition at the *5th World Congress on Alternatives and Animal Use in the Life Sciences* in 2005 was organised by InterNICHE, with National Contacts and collaborators as trainers. Demonstrations of alternatives for campaigners in the former Soviet Union were held in 2005 and 2006, with presentations, demonstrations and training in alternatives to over 500 teachers and students, and agreements at two institutes to replace harmful animal use in education across a whole department and faculty respectively (Jukes,

ALTEX 22, 4/05 p269-274). InterNICHE training is planned for other conferences and outreach tours in Europe, Latin America, Africa and the Middle East during 2006 and 2007. Alternatives from the Loan System, as well as expert training, are available on request from InterNICHE for the *6th World Congress*, being held in Japan in 2007.

2.5 Humane Education Award and freeware production

Life science courses across the world often show great similarity, and this is reflected in the practical classes and the animal use employed. Moreover,

many individual alternatives are suitable for wide-spread implementation in such diverse locations. Despite this commonality and potential, however, specific local needs and other issues concerning alternatives, such as language and other cultural aspects, cost, tailorability, and a sense of ownership all play important roles. To address this, since 2002 InterNICHE has offered an annual Humane Education Award of 20,000 Euro to support multi-local development and implementation of alternatives (*InterNICHE, 2006*, <www.interniche.org/news.html#award>). Supported by Dutch organisation Proefdiervrij, this grant program is targeted at teachers or others who could bring about replacement through the production of new alternatives or the purchase and implementation of existing products. Submitted projects are judged on their potential to replace harmful animal use, potential pedagogic effectiveness, overall ethical design, commitment to open source, and other factors.

The Award has been focused regionally, beginning with south-eastern Europe and then India, and is now global. Examples of projects funded include the following: First, the production of a freeware pharmacology compilation software in India, with over 3000 CDs distributed directly to teachers in the country. At just 3 universities, a total of 1600 animals were directly replaced by the software, so a much higher degree of replacement is likely to have been achieved nationally. Second, the production of a dual language physiology freeware in Romania and the establishment of a multimedia lab using reconditioned computers. The annual use of 1000 animals has been replaced at the department where the software was produced. Both freewares have also been distributed worldwide by InterNICHE National Contacts and translations into other languages are also under production. Third, the implementation of an advanced self-experimentation apparatus in Croatia, which as well as the replacement achieved has enabled new physiology practical classes to be established that were not possible with the animal labs. Fourth, replacement of live veterinary surgery labs in the Ukraine with ethically sourced dog cadavers that are perfused for simulated live surgery practice using Aboud's Method (*Aboud, 2004*).

3. Conclusion

Veterinary education and training deserves further investment to provide all students with the most

ethical and effective methods for the acquisition of knowledge and skills. Such an investment in alternatives will benefit all the groups concerned—not only the students, the teachers, and the animals, but also the veterinary profession and society in general. The replacement of harmful animal use has been gaining momentum across the world, in veterinary medicine as well as in human medicine and biology. Innovation in the field of education and training is providing an ever-increasing number of high-quality software products, mannekins, simulators, and other alternatives to the harmful use of animals as teaching and training aids. And a new generation of veterinary students is graduating, having experienced the best practice teaching made possible by this creativity and curricular transformation. They will be a generation of veterinarians who have not, during their education, gone against the creed of “First, do no harm.”

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