Guidelines for Humane Education: Alternatives to the Use of Animals in Teaching and Training

Adrian J. Smith and Karina Smith

Norwegian School of Veterinary Science, Laboratory Animal Unit, Oslo, Norway

Summary — There are few areas of animal use that are so emotive as that of their use in education. The physical presence of an animal (whether alive or dead) is a dramatic event for most students, and the effects it has will depend heavily on their previous experience with that species, their moral values and the perceived necessity of the practical. Much of the literature on this subject is highly emotive and based on relatively little data. This paper attempts to clarify the issues raised, presents an overview of the alternatives available with their strengths and weaknesses, and finally offers guidelines for humane education that take into consideration both the practical issues and the feelings of all those involved.

Key words: *alternative, animal, education, humane, reduction, refinement, replacement, supplement, teaching, training.*

Address for correspondence: *A.J. Smith, Norwegian School of Veterinary Science, Laboratory Animal Unit, P.O. Box 8146 Dep. N-0033 Oslo, Norway.*
E-mail: *adrian.smith@veths.no*

Introduction

Although the concept of the Three Rs (*reduction, refinement* and *replacement*) developed by William Russell & Rex Burch (1) was mainly intended to address animal use in research, there are many parallels to the use of animals in education and training. These parallels have resulted in legislation in many countries that affords animals equal protection whether they are used for experimentation or for educational purposes. Russell & Burch made several predictions about alternatives in education, despite the fact that audiovisual aids were in their infancy in the 1950s when the Three Rs concept was developed. They wrote, "The listing and distribution of films and filmstrips for demonstration may be an important mode of humane progress in teaching. Television, too, might be pressed into service here" (1).

On the subject of animal models, William Russell wrote, in 1955, "We may need the animals, as it were, on the night, but the machines will do very well at rehearsals" (2).

This wise comment summarises the role of many animal replacements, namely, that they also have a role in training situations where animals will be used eventually. Students can learn many of the basic techniques, and avoid elementary errors that would have harmed the animals, if they train on non-sentient material first. However, to use Russell's analogy: do we need animals at the dress rehearsal? The correct time and place to relinquish models and start using animals will vary from case to case.

The definition of "harmful" animal use in education needs to be defined. Many animal welfarists do not limit this definition to animals involved in practicals that evidently cause discomfort or pain, but include the killing (by humane means) of animals for dissection or to obtain material for experiments, as well as terminal experiments on anaesthetised animals. Many will argue that these practices are not "harmful". Indeed, Russell & Burch wrote the following (1):

We may consider experiments in which animals are still required, but only to furnish preparations after being painlessly killed . . . Provided the euthanasia is satisfactory, and provided there is a substantial reduction in numbers, such experiments are beyond reproach.

Not everyone would agree with these sentiments today.

Similar disagreement can arise over the use of animals that are surplus to other requirements, such as those from breeders or research projects. The expression "ethically sourced" is restricted by many to those animals that have died of natural causes, or that have been humanely killed because of illness, and does not include, for example, slaughterhouse material or surplus animals. Clearly, the attitudes of all stakeholders (animals and humans alike) are an important part of the assessment of animal use in education. Other practical issues, such as the possibility of spreading disease (to other animals or even to humans) must also be considered.

Likewise, stakeholders' views on the ethics of animal sources vary considerably. Purists argue that even surplus animals from lab animal breeders, or

lab animals that are no longer needed for that purpose, are not "ethically sourced". They would reserve this term for animals that have died of natural causes or animals humanely killed because of disease.

The Extent of the Problem

Current national statistics for the numbers of live animals used in research indicate that the number of animals used in education and training are modest. Figures are generally well under 1%, and often as low as 0.1–0.2% (3–5). However, the number of animals used in dissections is still extremely high in many countries. In the USA, it is estimated that approximately six million vertebrates are still used annually in schools, although reliable statistics are not available (Lesley King, personal communication). Jonathan Balcombe (3) attempted the first global perspective on education. He concluded that animal use in education was widespread and that regulatory oversight was poor, since most legislation does not govern the dissection of dead animals. There are a number of potential problems related to dissection, including the transportation, holding and killing of these large numbers of animals, and the effect on indigenous populations if the animals are obtained from the wild.

The Legislation

In Europe, the use of animals in education and teaching is mentioned specifically in both the EU *Directive 86/609/EEC* (6) and the *Council of Europe Convention ETS 123* (7). For example, Article 25 in the Convention states that:

Procedures shall be restricted to those absolutely necessary for the purpose of the education or training concerned and permitted only if their objective cannot be achieved by comparably effective audiovisual or other suitable methods.

In the explanatory report for this Convention, this position is reinforced:

Article 25 emphasises the importance of justifying the need to perfom procedures on live animals as an essential and unavoidable part of the education or training concerned, before they are allowed. The scope for using alternative teaching methods must always be fully explored and considered.

Many European countries have incorporated similar attitudes into their national legislation. For example, the Norwegian *Animal Welfare Act* of 1974 (8) states that animals may only be used in teaching when they are a necessary part of a professional training. Thus, two conditions have to be fulfilled before live animals may be used in education or teaching:

1. their use must be essential; and

2. their use must be limited to professional studies.

There is an interesting legal consequence of this legislation. If a non-animal alternative is offered to students with conscientious objections, and the teacher indicates that the same learning objectives can be met with the alternative, the animal practical is by definition illegal! Many schools now offer a non-animal alternative to animal practicals. Clarification of the objectives of a teaching session is therefore an essential part of assessing animal use in education. These potential conflicts are a good argument for, wherever possible, the "mainstreaming of alternatives" (9). Even within professional studies such as veterinary medicine, it is not always easy to assess the necessity for animal use. A good example of this is the preclinical part of the course, where animals are not primarily being used to teach practical skills. Time constraints during the clinical phase may be a good argument for starting "clinical" training early in the course. On the other hand, if preclinical practicals are the students' first encounter with living animals, and these animals are to be killed, this can create serious moral dilemmas for sensitive students, who not only feel responsible for their deaths, but also that the teaching is in conflict with the principles of modern laboratory animal science.

There is also a need for re-evaluation of clinical studies where animals are used, such as in veterinary medicine. Care must be taken to avoid the overuse of clinical cases. In many cases, of course, there is no substitute for hands-on experience when learning to appreciate complex interactions in living organisms. However, the use of cows to train students in pregnancy diagnosis and artificial insemination is a classic example of animal use that needs careful assessment, to avoid subjecting a few animals to painful examinations by large numbers of students.

The technicians attending live animals, or responsible for killing them, must also be considered, particularly if there is any suspicion that they doubt the necessity of the animal use. Little research has been done into animal technicians' attitudes and experiences.

The scheme for accreditation of courses in laboratory animal science initiated by FELASA (10) will gradually help to improve quality assurance in this area of animal use. The best time to teach practical

skills to researchers and technicians still remains to be discussed in detail. There is undoubtedly no one "best practice", but it is important that some system of quality control is present wherever teaching is given.

Firm conclusions are yet to be reached on this issue. Our own analyses of animal use on FELASA category C courses for researchers (unpublished data) showed that 95% of participants (n = 223) described the limited animal use as "very good" or "excellent". Practical training in Norway is largely given as on-the-job training, under supervision of suitably qualified personnel, since animal use in this country includes a large range of non-traditional species, such as farmed salmon, forest wildlife and aquatic species.

An Overview is Needed

There are now a great many sophisticated audiovisual aids on the market. However, many of the companies that supply them produce just a few products and aim at a small segment of the market. Many alternatives have been created by university staff, with limited resources, and therefore, poor product support. In addition, many of the earliest products were very simple simulations that just illustrated bodily functions in a qualitative fashion. These factors gave alternatives a somewhat poor reputation in the early stages of their development.

It is therefore vital that teachers have access both to overviews of everything that may be of relevance to their field, and also to peer reviews of the best teaching materials. The former is important, because many teaching situations can be enhanced by adding types of audiovisual aid that the teacher has not necessarily considered. Availability of peer reviews is important in convincing teachers who have run animal practicals for many years that their colleagues are achieving equally successful results with alternatives (11). There are a number of initiatives addressing these challenges.

Overviews of animal alternatives

Comprehensive databases such as NORINA (http://oslovet.veths.no/NORINA) and AVAR (http://www.avar.org), bibliographies such as those produced by AWIC (http://www.nal.usda.gov/awic) and resource centres such as CALF (Computer Aided Learning Facility) at the University of California Davis (http://www.calf.vetmed.ucdavis.edu) have in recent years greatly facilitated the search for information on alternatives (12). The InterNICHE (http:// www.interniche.org) organisation has produced a comprehensive textbook on animal alternatives, with information on a large number of products. Many audiovisual aids can also be loaned at modest or no charge from organisations such as InterNICHE, The Humane Society of the United States (HSUS, http://www.hsus.org) and the National Anti-Vivisection Society (NAVS, http://www.navs.org).

A European Resource Centre for Alternatives in Higher Education (EURCA, http://www.eurca.org) has recently been launched to provide peer reviews of products that are of special value in higher education. EURCA has its own database, with a small number of products, its strength lying in the aim that all items mentioned here are to be accompanied by a peer review. In many cases, additional comments from users, including worksheets and other supplementary material produced by teachers using these products are also available. The EURCA database holds information on 50 products at present, largely computer simulations, but hopes to expand this to 150–200 reviewed items within two years. EURCA's main role is, however, to ensure that suitable products are demonstrated to relevant teaching establishments. EURCA staff members demonstrate these products at scientific meetings and higher education institutions.

Unfortunately, there is at present no equivalent service for lower education levels, although animal welfare organisations, such as The HSUS, provide detailed advice for schoolchildren seeking alternatives to dissection. Recent publicity of schoolchildren in the US who have refused to participate in dissection classes will no doubt accelerate the development of such a service.

Efforts have begun to harness the strengths of these two different approaches by increasing collaboration between database providers and review sources. The NORINA database now contains hotlinks on all products that are available through the loan schemes of InterNICHE, The HSUS (and its sister organisations abroad) and NAVS, as well as to all items in the EURCA database of peer-reviewed material for use in higher education. Thus, teachers or students searching for animal alternatives have two options. They can either begin their search in a comprehensive database, such as NORINA, knowing that they will be led to other sites offering peer reviews or product loans, or they can begin in a specialist database, such as EURCA's, moving on to NORINA to broaden their search once the more limited area of interest has been examined.

The development of the NORINA database (13) over the last ten years illustrates many of the challenges and opportunities faced when implementing alternatives to animal use. NORINA currently contains information on 3700 alternatives that have been categorised into 36 product types and 23 biomedical fields. Users may limit their search to,

for example, CD-ROMs within pharmacology or videos on anatomy. Free text searching is fully available for those who are initially unsure of their needs.

NORINA aims to give an overview of everything of possible relevance within the biosciences. The rationale behind this is that many products are relevant to several fields. Models designed for anatomy teaching in human medicine may well be sufficient to replace animal material in schools or preclinical veterinary classes. We also have examples of medical surgeons who were not aware of models relevant to their work until they attended a course in laboratory animal science where the NORINA database was presented.

There are many products that, although not strictly defined as alternatives, may lead to the reduction in numbers of animals used, or to refinement of techniques where animal use is still essential, such as in training of animal technicians and researchers who will still be using animals. NORINA also includes information on training programmes in the hope that these will reduce animal use and refine users' skills before they begin using live animals.

There are many literature sources within the field of laboratory animal science that also contribute to the Three Rs. Accordingly, we have also developed a literature database (TextBase, http://oslovet.veths.no/textbase), which complements NORINA. TextBase currently contains information on approximately 1000 textbooks and other written material, including core laboratory animal science textbooks, dissection guides, anatomy charts and the like, with hot links to NORINA, publishers and online reviews in journals such as *Laboratory Animals* (http://www.lal.org.uk). Both NORINA and TextBase are available free-of-charge on the Internet and are continuously updated.

An Overview of Animal Alternatives

More information on products mentioned below may be obtained by entering their product number [given in square brackets] on the search page of the NORINA database: http://oslovet.veths.no/NORINA/search.html.

Charts, slides and dissection manuals

Although many of these products were developed as aids to dissection practicals or anatomy lectures, they may well be useful as animal replacements. Examples include the Dissectogram charts provided by Wards [1626], covering animals such as the frog, fetal pig and perch that are regularly used in dissections.

3D models, simulators and manikins

Many of these products were developed for medical, nursing and dentistry training, but are of value as animal replacements. These vary in their complexity, the more advanced models displaying detailed anatomy and pathological states, such as *The Heart of America* series [3048]. Others, such as the *Rabbit Ear Venepuncture Simulator* [4900] were designed specifically to teach techniques that will eventually be performed on animals.

Preserved materials

These include animal specimens fixed in a preservative such as formalin, and plastinated models where latex replaces the animal tissue. Using these techniques, a teaching institution can produce exactly those models it needs for specific courses.

Computer programs and CD-ROM

Computerised teaching material can include a variety of other media that have been digitised, such as text, pictures, music and sound. Their use as animal replacements has been reviewed elsewhere (14, 15). There are basically three types of computer program.

1. Computer emulations. These products concentrate on teaching principles rather than depicting quantitatively accurate responses. An elegant example in this category is *Pharmatutor* (16), which was one of the first computerised animal alternatives to be developed [22]. *Pharmatutor* shows the effect of a number of pharmaceuticals on heart rate and blood pressure.

2. Computer simulations of preparations. These use mathematical algorithms to generate quantitative, simulated tissue responses. They allow control over experimental parameters and are good for teaching experimental design. They are highly flexible but need significant direct or indirect tutor support if they are to be used intelligently. This may be an advantage, particularly on courses where the students otherwise have little contact with staff. The *Guinea Pig Ileum* (17 [855]) is an example of this category.

3. Computer simulations of experiments. These use real data to generate simulated tissue responses. They are therefore lifelike and use tutor-designed experiments of high relevance. There may be on-screen support and interactive self-assessments. In contrast to the previous type, they can be used for self-directed learning. An example of this category is the *Rat Blood Pressure* (18 [4447]).

Films, photographs, video and interactive video

These more traditional audiovisual aids still retain their value in biomedical teaching. Picture resolution is normally high, enabling details to be shown clearly. Interactive video has now largely been replaced by CD-ROM presentations, since laserdiscs and their hardware are no longer readily available. The development of digitised video has enabled film sequences to be added to computer simulations and lecture presentations (e.g. in Powerpoint), greatly increasing their usefulness.

The *Investigation of a Mammal (Rat)* [4248] is a good example of this category. Slides, photographs and a video of a real dissection provide enough material in many cases to be able to dispense with the use of animals in school classes.

Presentations on the Internet (World Wide Web)

The possibilities afforded by the Internet are still in their early stages of development. Many relevant materials are available free-of-charge, such as the *Canine Brain Atlas* produced by the Faculty of Veterinary Medicine at the University of Minnesota (http://www.vanat.cvm.umn.edu/vanatCrsware/NeuroAnat/CanBrainAtlas.html).

Many teachers have old 35mm slide series that are excellent teaching aids, yet they are less easily shared with colleagues. These can easily be scanned, digitised and incorporated into text that may be presented on the Web. This is a cheap and effective method of sharing teaching material. A slide series showing bleeding techniques in pigs of all ages (http://oslovet.veths.no/teaching/pig/pigbleed), produced by veterinarians at the Norwegian School of Veterinary Science, Oslo, has proved to be extremely popular. Thumbnail pictures are used to give the reader a quick overview of the scope of the presentation, and the larger pictures are accessed by clicking on the thumbnails.

Virtual reality

The ultimate feeling of being in contact with an artificial object is achieved by virtual reality, an advanced form of computer simulation where the observer's visual field is completely filled by images from computer monitors, and tactile stimuli are provided by gloves equipped with special sensors. These simulations are expensive, but they have been developed within, for example, the field of endoscopy [4060].

Simulators have also been developed that combine the use of real animal tissue and electronics. For example, the *P.O.P. Simulator* [4412] can be used for training in laparoscopic surgery.

Experiments on humans

Many biomedical courses involve some degree of self-experimentation. Students are usually highly motivated for this type of class and appreciate the relevance of the data they collect. Such experiments are not, of course, totally without risk, and this should be assessed at an early stage to avoid insurance claims or lawsuits.

The use of animals is, of course, not without risk, either. Allergy, asthma and physical injury (bites, scratches and kicks) are very real dangers. Institutions offering animal-related courses, such as veterinary medicine, animal nursing and agricultural sciences, should have adequate policies to prepare potential students for these risks, and to exclude persons with unacceptably high chances of developing illness (e.g. asthmatics).

Experiments on plants

These include biochemical studies of enzyme systems that are similar in mammals and plants, such as the ATP energy system.

Other alternatives

Many students consider animal use acceptable if the practical utilises animals that have not been solely obtained for teaching purposes. Examples include:

1. Ethically sourced cadavers or animal material. Most students are prepared to use cadavers if these are animals that have died of natural causes or that have been euthanised because of disease. Some will extend this definition to slaughterhouse material, although others view the rearing of food-producing animals *per se* as unethical.

2. Animals in need of clinical veterinary care, which are treated, under close supervision, by students.

3. Laboratory animals surplus to breeding or research requirements.

4. Animals studied in their natural setting, or in brief periods of captivity.

Finally, a form of replacement is just to replace the animal practical with a lecture where the practical is described using standard classroom aids. This option can generate a great deal of ill feeling among the students if the impression is given that the animal practical was valuable, but was removed simply to satisfy regulators or the opinion of the majority.

Strengths and Weaknesses of Alternatives

It must also be remembered that alternatives may be excellent as briefing or debriefing aids, even if they are not of sufficient quality to replace a wetlab entirely. This is one reason why the NORINA database offers as large an overview of audiovisual aids as possible, in case the teacher has not considered all possible alternative media or products.

Models are often criticised for being an oversimplification of the complex biological structures they attempt to display. However, as Russell & Burch (1) pointed out:

Nobody has ever pretended that these very simple models are of more than negligible fidelity for the system as a whole for whose study they are designed. But these relatively primitive gadgets will answer many preliminary questions that might otherwise be put to albino rats on electrified grids.

Another frequent criticism is that they exaggerate or neglect important properties of the organism in question. It is important to understand the concepts of fidelity and discrimination, and the differences between these, which lie behind the production of a model. Here, again, we find a clear description of these concepts in Russell & Burch's book (1).

Fidelity describes the overall proportionate difference between a system (in this context a model or computer simulation) and another system (in this case the animal or tissue). The term "High Fidelity" has been widely used in music to indicate that a recording device reproduces all the sounds created by the musicians equally faithfully (or equally poorly, as Russell & Burch dryly remarked).

Discrimination, on the other hand, is a measure of the extent to which the model reproduces one particular feature in which we are interested. A feature may be deliberately overemphasised, to make a pedagogical point. These models create, hopefully, a better understanding of part of a biological process. To emphasise this point, Russell & Burch quote the British statesman Lord Kelvin, who reputedly said, "If ye canna mak' a model, ye dinna understan' it".

The Psychology of Learning

The use of animals in teaching and education inevitably raises moral and ethical issues that may trigger profound psychological effects in those involved. Research into the psychological effects on students of different learning situations, particularly where students perceive animal misuse has been reviewed (19). An optimal level of stimulus is necessary for the learning process, regardless of whether this learning is a favourable or unpleasant experience. An element of chance also enhances learning and increases motivation. This must not, however, lead in any way to a feeling of 'learned helplessness' on the student's part, where a feeling of waste and revulsion dominates the experience.

The learning curve can be influenced by, among other things:

— Stressful experiences during the teaching session.

— Motivation to learn.

— Repetitive activity that reinforces the aquisition of practical skills.

— The signal/noise ratio, i.e. the extent to which the teaching exercise allows the student to focus on the tasks to be taught, without disturbances due to, for example, moral doubts.

— Reminiscence after the teaching session, where events are recounted and discussed.

— The tutor's charisma and powers of persuasion.

It is important to remember that students can experience psychological trauma not only from their own participation but also from watching others use animals. The best designed animal practical will have no teaching value if the students are so disgusted or upset by what they see that these impressions overrule all other input. In some cases, this may lead to withdrawal from or opposition to science as a career choice. Others, to protect themselves, may adopt a more utilaritarian view, in which they allow themselves less compassion for the animals, as a form of survival. Furthermore, many participants find it difficult to object publicly in the face of peers, where an element of competition may worsen the situation even further. Thus, many teachers are unaware of the problem until an anonymous questionnaire is used to evaluate a practical.

Evaluations of the Impact of Animal Alternatives

Many studies have been made to assess the effects of animal use and alternatives on students, both in terms of emotional consequences and knowledge gain (20–26). The results of such studies are often quoted to support more-anecdotal impressions. It is vital that questionnaires and other means of sampling students' views are constructed correctly, to avoid bias. The Likert method of scaling (27, 28) is widely regarded as a good means of collecting unbi-

ased data, providing a number of conditions are met. These include:

1. The questionnaire must contain a set of clear, strong claims to which the respondent must take a stand.

2. Each question should have 4–6 alternative answers or degrees of intensity.

3. Equal numbers of pro and contra claims must be included in the questionnaire, in random order. During data analysis, the claims should each be allocated a number of points so that people endorsing positive claims score consistently higher.

Elementary mistakes seen in questionnaires include:

1. Not defining the area in question well enough (e.g. "are you opposed to animal use in education?").

2. Inadvertently generating identical answers because the questions are poorly defined.

3. Respondents not being allowed to grade their opinions.

4. Use of irrelevant or hypothetical questions that steal time and energy from the important issues.

5. Attempting to measure intensity of opinion with Yes/No answers.

6. Problems with tackling blank answers or comments written by the respondents in the margins.

Results of Research into Students' Attitudes

David Dewhurst (21–23, 29) and Ian Hughes (30) have considerable experience in assessing the value of computer simulations as animal alternatives in higher education in the UK. Their conclusions may be summarised as follows:

— many learning objectives can be addressed with alternatives, but not all;

— knowledge gain is equivalent;

— data handling and experimental design can be learned with alternatives;

— communication skills (oral and written) are comparable;

— group work and staff–student interactions are fully possible;

— students are generally positive about using computer-assisted learning;

— costs are less; and

— better support is available for weaker students.

There is some evidence that wetlab students developed longer-lasting (deep) learning (30). This needs to be addressed further and is of particular relevance to career studies such as veterinary medicine. It is important to remember that most of the evaluation work cited above has been done with physiology and pharmacology students, the majority of whom will not need practical skills involving animals in their future careers.

Hagelin, Hau & Carlsson (25, 26) have evaluated the attitudes of veterinary students to animals in a number of countries. In general, the vast majority accepted some form of animal use in research, with students from rural backgrounds being most positive. This acceptance increased as they progressed through their course. Education in laboratory animal science tended to increase their understanding of a need for animal research.

Our own experiences with veterinary students in Oslo over the last 15 years (unpublished data) suggest:

— many students are just as ethically sceptical to small demonstrations as they are to large-scale animal use;

— there are large variations in attitudes between classes;

— older classes influence attitudes in younger ones and vice versa;

— key personalities may influence class views, in both directions;

— views change as students progress and obtain a more complete overview of their education;

— the majority accept limited animal use that clearly has a purpose, and they dislike its removal unless a full-value alternative is available; and

— students are more concerned about whether they will gain the necessary practical skills that they feel they need before they qualify.

An informal survey of European and US veterinary schools, which we conducted in 1991, exposed widely differing views among the lecturers involved in preclinical teaching at that time. The comments of two lecturers illustrate these differences:

— "Animal use has no place in preclinical teaching".

— "I regard it as the height of hypocrisy for any student to object in principle to the use of experimental animals for legitimate scientific purposes".

Conclusions

It can be of interest to examine briefly the mechanisms acting in educational establishments that work to promote or hinder the introduction of alternatives. The most important of these mechanisms are summarised below (31).

Forces acting to encourage the introduction of alternatives

There are basically two sets of stimulants, some positive and others negative. Positive stimulants include:

— availability of information on alternatives;

— demonstrations by colleagues;

— availability of peer reviews and evaluations;

— the flexibility of the teaching resources;

— teachers with a positive attitude; and

— the excitement of new technology.

Stimulants that promote the introduction of alternatives in a more negative sense include:

— purely legislative demands;

— economic pressures due to the cost of animal practicals; and

— pressures from students.

Forces acting to delay or prevent the introduction of alternatives

These forces include the following elements:

— problems of validating potential alternatives;

— previous experience of poor products that did not meet the original objectives;

— a reluctance to acknowledge an ethical problem;

— the cost of alternatives (usually a short-term problem);

— access to limited information about possible alternatives;

— the feeling of loss of academic freedom;

— a general reluctance to change established teaching courses;

— a fear that this may lead to poorer teaching quality;

— a fear of language barriers if foreign alternatives are employed;

— a reluctance to use methods developed elsewhere (the "not invented here" syndrome);

— the fear that decreased animal use may also have repercussions on other areas, such as research (the "thin end of the wedge" syndrome);

— anticipated problems in assessing student response (this is no more difficult than when using animal practicals, but is all too infrequently done); and

— concerns about the future of animal technicians at those institutions where animals are largely kept for teaching purposes.

Both animal practicals and alternative sessions have their own sets of special characteristics. It is important to be aware of the differences between these two approaches.

What are the characteristics of animal practicals?

Animal practicals are complex sessions that demand a lot of staff and student time, with adequate technical support. The animals must, in most cases, be housed prior to the practical, and their specialist accommodation is expensive. Sensitive students will quickly associate with the animals and consider themselves responsible for the unnecessary deaths of healthy animals merely to pass on existing knowledge. "Failed experiments", in which the student gets unexpected results (even if these are, in fact, merely a result of normal biological variation) are often looked upon as an added waste of animal life.

The intimacy of an animal practical can, on the other hand, promote active and interactive learning in a fashion that is otherwise missing from many classes with large numbers of students. It promotes training in group work and provides close staff–

student contact. Laboratory skills are learnt in a more realistic fashion, although for many students, this may be unnecessary unless they decide to pursue a research career. It is argued that it is therefore better to reserve animal practicals for those students who will need the practical skills.

What are the characteristics of alternative methods?

Student reactions tend to be positive to the use of alternatives, although this depends greatly upon how the alternative is presented, the type of education in which they are used and their degree of successful integration in the course as a whole. They are usually cost-effective, provided that the acquisition of laboratory skills is not a primary objective. They avoid the traumatic psychological events that can occur with animal use. Experiments can be repeated indefinitely, with no constraints of time, place or pharmacology (e.g. wash-out limitations). No ambiguous or incomplete data are collected and every experiment is deemed "successful". Built-in self-assessment is easy to arrange, and animation techniques allow "fly-through" experiences that are impossible in real life.

The success of alternatives depends on what is measured. Knowledge gain is equivalent, at any rate in the short-term. They are useful for developing skills in data handling and experimental design, but not for practical skills. Teachers must largely accept that different goals are achieved and must therefore closely define their primary objectives.

Teachers should increase their awareness of alternatives and develop their own support materials, whether they use alternatives or not.

Suggestions for guidelines when planning teaching/training potentially involving animals

The key to successful implementation and use of alternatives can be summarised as the "closeness of fit" between the educational objectives and the choice of alternative or supplementary medium.

The first necessity before replacing animal use is therefore to define clear objectives for the teaching. Such objectives may be the development of:

— laboratory skills;

— general animal handling skills;

— preparation-specific animal skills;

— skills in ethical thinking;

— knowledge gain or the reinforcement of existing knowledge;

— data handling skills;

— skills in experimental design;

— communication skills (oral and written);

— experience with group work; and

— good staff–student interactions.

Many of these objectives can be met without the use of animals. However, all teaching and training must also be seen in its wider context. For example, animal use is often considered less necessary in preclinical training than in clinical teaching. Too rigid divisions between preclinical and clinical teaching objectives should be avoided, since the demands on students in many professional curricula necessitate early acquisition of practical skills if they are to be suitably qualified by the time they graduate.

Once the objectives have been clarified, the following points should be addressed:

1. Both the letter and the spirit of relevant national legislation must be followed. In many cases this necessitates clear evaluation of the need to perform experiments on live animals. Relevant guidelines should also be adhered to. These include those written by the Institute for Laboratory Animal Research (ILAR; http://dels.nas.edu/ilar/) and the International Science & Engineering Fairs (ISEF; http://www.sciserv.org/isef/teachers/rules_regulations.asp).

2. Focus must be kept on animal ethics and respect for life. Many students are in the process of forming their own sets of ethics, or have already done so, and many of these focus heavily on animal welfare.

3. Alternatives should be "mainstreamed" (i.e. considered as the rule rather than the exception), and they should be assumed adequate until animal use is proven necessary to meet clearly defined objectives.

4. All teachers must be given sufficient insight into what is available in the way of alternatives.

Where animal use is unavoidable, the following principles should be applied:

1. Animal use should be limited to the clinical phase of the study or, as a minimum, used in addition to teach other aspects of animal function, to maximise the benefit of the practical.

2. Animal use should be approved by an ethical committee, which may be the Institutional Animal Care and Use Committee (IACUC) or a special committee appointed for the purpose. Such committees should contain representatives from:

   — teachers involved in the courses under discussion;

   — teachers involved in animal use at other levels, where appropriate (e.g. clinical divisions of a veterinary education);

   — students approaching the end of the study (who therefore have the best overview of where necessary skills involving animal use may be learned); and

   — a representative for the animal facility providing the animals.

3. Animal practicals should be classified according to level of severity, to increase the focus on the need for adequate care during and after the exercises. Such a classification will also aid in deciding whether an animal practical is necessary or not.

4. Students should be informed as early as possible as to the content of practicals involving animals or animal material.

5. Teachers should explain the reasons for including the animal labs, and why alternatives were rejected.

6. Teaching should be designed to be as comparative as possible, focusing on biology, respect for the animals, handling and simple techniques of relevance to more than one species.

7. Teachers should develop sufficient support materials of their own to motivate the students to participate actively.

8. Sufficient competent and motivated demonstrators must be available to answer scientific questions as well as to allay concerns related to animal welfare and ethics.

9. A Disaster Plan covering relevant health risks must be available, along with suitably trained staff. Such risks may include, among other things, bites, scratches, needle sticks, allergy, asthma and fainting.

10. All staff involved should be honest, humble and sympathetic to the students, and they should set aside sufficient time for a discussion after the practical if desired.

11. All participants on every course should be provided with questionnaires, and teachers should be prepared to act on any consistent trends.

12. Comprehensive evaluation studies should be regularly performed, using opinion polls based on Likert scaling.

Above all, dialogue should be maintained between educators, students and animal caretakers. An atmosphere of mutual trust and respect is essential if progress is to be made in implementing the Three Rs in education.

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