Session 1.2
Replacement alternatives in education: Animal-free teaching

Alternatives to Animal Experimentation in Undergraduate Curricula at Medical Schools – Analysis of Current Trends in the Czech Republic

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Summary
Undergraduate medical students should be both theoretically and practically informed about the existence of alternatives to the use of animals in research and in education. Therefore we have prepared a course based on the 3Rs concept. In this course students learned and practically mastered the following topics:
- *The 3Rs concept – scientific background, ethical and legislative considerations*
- *Mammalian cells cultivated in vitro as an alternative to experiments on animals*
- *Non-invasive student self-experimentation as an alternative*
- *Screen-based alternatives (interactive computer programmes) as an alternative*
- *Proper use of laboratory animals*

We prepared a written anonymous questionnaire to evaluate students' opinions on the course and their attitudes towards the alternatives. The results of the survey showed that our students were generally satisfied with our course and it seems that both experiments with cells in vitro and human experimentation could be suitable alternatives in medical education.
Due to the fact that we organised similar surveys several times during the last 15 years, it was possible to analyse changes in the students' attitudes during that period. The results showed one obvious general tendency: current less strict opposition of students towards animal experimentation, with a substantial part of our respondents even requiring animal experimentation. Reasons behind these changes are discussed.

Keywords: alternatives, animal experiments, education, faculty of medicine, curricula

Introduction

Animals used for teaching and education purposes represent only about 1% of all laboratory animals used for any purpose. Despite this fact, teaching alternatives to the use of laboratory animals is very important, because it forms the attitudes of students for their whole life (van der Valk, 1999). The main goal of this article is to present a brief historical survey of changes in the use of laboratory animals in education at the Faculty of Medicine in Hradec Kralove over the last 15 years. Subsequently, the current situation at the faculty is described, including positive achievements in this field as well as speculations about future trends. Focus will mainly be on the situation at our faculty, considering that the situation is very similar in all

seven medical faculties in the Czech Republic. We believe that our data are relevant for all undergraduate students of medicine in our country.

Situation in the 1990's

Use of animals in education at universities has a longstanding tradition in our country; it used to be a standard element of the curriculum at all medical faculties. Before 1990, laboratory animals were easily obtained and there was no legislation concerning their use. Generally, in this field there were no regulations and practically no restrictions.

After the revolution in November 1989, the attitude of our society changed substantially and the protection of animals became one of the important though controversial issues. Our federal parliament voted for a new Animal Protection Law in April 1992 (Czech National Council, 1992). The law was in very good concordance with EC directive 609-1986 (Council of Europe, 1986) and has since been amended several times to be in full harmony with current EU legislation.

At the Faculty of Medicine in Hradec Kralove we tried to promote changes in the attitude of teachers and students towards alternatives immediately after the revolution. At that time we had personal contacts with leaders in the field of alternatives, namely with Nottingham University Medical School (Department of Human Morphology), FRAME, Free University of Berlin and ZEBET. Together, we prepared a proposal for the TEMPUS Joint European Project No. 1485 "Alternatives to Experiments with Animals in Medical Education". This project affected the situation at our faculty substantially.

The main goal of this Joint European Project was to introduce the 3Rs concept and practical approaches to alternatives to animal experiments in the education system, and promote:

- Improvements in the curricula at the medical faculty
- Work of committees for proper animal use at the medical faculty
- Training in the practical use of alternative methods
- Production and exchange of new teaching materials concerning alternatives
- Improvements in husbandry and care for laboratory animals
- Obligatory regulation of experimentation with animals

The results of this project were summarised at the TEMPUS evaluation meeting in Hradec Kralove in May 1994 and published as a book (Cervinka and Balls, 1995). We are obliged to TEMPUS Office and to our friends in EU countries (M. Balls, H. Spielmann, R. Clothier, M. Liebsch, and others) for their longstanding support.

As a result of these and other activities, there was a very marked decrease in the use of laboratory animals for teaching purposes at our faculty. In table 1, the numbers of laboratory animals used for teaching purposes in the period of 1991-2004 are given. It is clear that there was a very rapid decline in the use of laboratory animals at the beginning of the 90's, from 1830 to 160 animals per year. Since that time the numbers have remained almost constant. In 1991, animals were used for teaching at eight departments in 36 practical lessons. Since 1995, laboratory animals were used for teaching purposes at only two departments – the Department of Physiology and the Department of Pharmacology.

Situation in 2000

At the turning point of the millennium, the situation at our faculty was stable. The system of proper animal use continues without disturbances. All students and teachers at our faculty follow strict regulations. Basic characteristics of our curricula can be summarised as follows:

- No use of dead animals for dissections
- No use of animals for surgical training
- Very limited harmful use of living animals. The Animal Welfare Committee must approve each proposal for the use of animals in education every year.
- Students may choose an animal-free alternative to these practical classes.

After many years of teaching surgery and other clinical subjects without using animals, it is obvious that the level of practical skills of our graduates remains the same. With this we can be satisfied. Nevertheless, we realise that most regulations at our faculty are restrictive. We think that restrictions are not the best way to change the attitude of people, and, in particular students. Therefore, we try to offer a positive alternative.

Current situation

We believe that undergraduate medical students should be both theoretically and practically informed about the existence of alternatives to the use of animals in research and in education. Students are exposed to a clear and thorough consideration of the advantages and disadvantages of alternatives. Each student has practical experience with alternative *in vitro* methods. Simultaneously, they should absorb basic facts about experiments on animals. Therefore, we have prepared a course module based on the 3Rs concept of alternatives. It is a joint co-operative action of two departments, one using animals in teaching (Department of Physiology) and the other using alternative *in vitro* methods in teaching (Department of Biology).

Tab. 1: Numbers of laboratory animals used for teaching purposes in the period of 1991-2004 at Charles University Faculty of Medicine in Hradec Kralove.

	1991	1993	1995	2000	2004
Rat	470	85	20	20	20
Mouse	740	490	120	30	0
Guinea pig	100	0	0	0	0
Rabbit	380	124	20	10	17
Frog	110	40	0	0	0
Dog	32	0	0	0	0
Total	1832	739	160	60	37

The Alternatives To Animals Module (ATA Module) is obligatory for all students of general medicine in the second study year. It consists of 3 practical classes and one seminar in physiology (together 12 teaching hours) and 2 practical classes in biology (6 hours). Each academic year about 150 students pass this course module. During the teaching activities we facilitate discussions among students on the topic of alternatives. Our ideas on this module were already presented at the Workshop on Teaching Alternatives in Warsaw in 2002 and at the 4th World Congress on Alternatives in New Orleans in 2002 (Cervinka and Cervinkova, 2003).

In the ATA Module students learn and practically master the following topics in five teaching blocks:

1. Concept of Alternatives. All students are informed about our goal – to promote progress towards the refinement, reduction and replacement of animal experiments. Extra time is spent on explanation of the 3Rs principle, on scientific background, ethical and legislative considerations, and on information about alternatives on the internet.

2. Proper use of animals. Currently, animals are used only in the following practical lessons: "Nervous and humoural regulation of the blood pressure in the rabbit" and "Perfusion of the rat heart *in vitro* – effects of drugs". These practical lessons are also used to deliver information about proper housing and handling of laboratory animals, about humane practice in conducting animal experiments and about legal and ethical aspects of animal experiments. Students can choose between animal and non-animal alternatives during practical lessons, with non-animal alternatives having the same educational level.

3. Computer models as an alternative in teaching (theory of systems, advantages of modelling, practical use of computer models as an alternative to animal experimentation). To carry out this module it was essential to build a new computer laboratory with new computer teaching programmes and to establish a new student teaching laboratory for cultivation of cells *in vitro*. For both of these activities, we received financial support from the Czech ministry of education. Also, we very much appreciate help from InterNICHE, Nick Jukes and other co-operators who helped with know-how and the selection of suitable computer programmes. The following programmes are now available: computer simulation of action potential (AXONLAB), modelling of neuromuscular transmission (CONDUCT), computer modelling of blood pressure regulation, computer simulation of oxygen transport, and computer simulation of kidney functions.

4. Non-invasive students' self-experimentation as an alternative method to animal-based models. Practical classes performed on student volunteers are the most common type of practicals in physiology, including haematology, neurology, physical examination of the cardiovascular system, physiology of the senses, oral glucose tolerance test and measurement of basal metabolic rate.

5. Practical use of mammalian cells cultured *in vitro* as an alternative in research and testing. In this part of the ATA module students are educated in state-of-the-art *in vitro* techniques. During the practical course organised at the Department of Biology, we introduce students to *in vitro* methodology and demonstrate the use of cultivated cells in various applications, such as toxicity assessment. Students are invited to discuss advantages and disadvantages of various models employed in the field of toxicology, especially with regard to recent developments in respective EU policies.

Special emphasis is placed on evidence-based *in vitro* models and on validation of alternative methods. For these purposes students are acquainted with the main information sources on the internet – each student individually searches for new information about alternatives. After this practical class each student knows where to find recent data about alternatives (Altweb, Norina).

Training in the practical use of alternative methods is organised at the Department of Medical Biology and Genetics and starts with an introductory lecture on *in vitro* cultivation of mammalian cells and their application in teaching and research, followed by an excursion to the *in vitro* toxicology laboratory. Finally, in one practical lesson students themselves perform testing of cytotoxicity of a selected chemical on the Hep2 cell line *in vitro*. Examples of these experiments include the photodynamic effect of selected chemicals on human and murine cell cultures and assessment of toxicity of some materials/substances used in human health care. These simple experiments serve to demonstrate usefulness of *in vitro* cell cultures in numerous areas of scientific experimentation. In our opinion, this hands-on experience greatly enhances the students' understanding of alternatives.

Student's evaluation

Since all our efforts of teaching alternatives are in a way unique in the Czech Republic, we need feedback from our students. This year we prepared a written anonymous questionnaire to evaluate students' opinions on the course and their attitudes towards alternatives. Due to the fact that we organised similar surveys in 1995 and 2000, it was possible to analyse changes in the students' attitudes over the past 15 year period.

The results of the survey showed that our students were generally satisfied with our new module, and it seems that both experiments with cells *in vitro* and human experimentation could be suitable alternatives in medical education. Generally, it is very positive that more than 107 students of general medicine participated in our enquiry, i.e. 70% of all students in the second academic year. Another positive point is the fact that very few students selected the option "I cannot answer" in any of the questions. This proves that all questions were precisely formulated and it is a strong indication that our students have firmly fixed opinions on the use of laboratory animals. The questions were grouped in four clusters.

The first cluster of questions was oriented on the use of laboratory animals in general. The majority of respondents (58%) believed that the use of laboratory animals for research purposes is essential (indispensable). On the other hand, only 44% of respondents believed that laboratory animals are essential in education, and 53% of respondents did not agree with this statement. Complete elimination of laboratory animals from the education process is supported by 32% of respondents, with 71% of respondents opposing this.

The second cluster of questions was focused on the use of laboratory animals at our medical faculty. It is heartening that the majority of students (72%) consider the extent of use of laboratory animals at our faculty adequate. 59% of respondents do not agree with the statement "The use of laboratory animals should be reduced" and 84% of respondents do not agree with the statement "The use of laboratory animals could be increased". Almost all students (96%) appreciate the option to refuse to work with animals without any sanctions.

The third cluster of questions focused on alternatives to laboratory animals. The majority (76%) of students voiced the opinion that they are sufficiently informed about alternatives to laboratory animals. Virtually all students (with only one exception) personally agreed with and accept the 3Rs principle. Practically all students considered incorporation of teaching about alternatives as important and essential in the curriculum at faculties of medicine.

In comparison with previous years, one general tendency is obvious, students are currently less strict in their opposition against animal experimentation, and a substantial part of our respondents even required animal experimentation.

Students were slightly more critical in the assessment of our lectures, seminars and practicals about alternatives. Still, the majority (78%) of students agreed with the general scope and focus of the course and with its syllabus. One special question was aimed at the only practical class where students work with living animals. This practical class is "Direct measurement of blood pressure in the rabbit". At the end of this class, animals under anaesthesia are sacrificed. Sacrifice notwithstanding, 71% of respondents considered this class appropriate. 83% of respondents very positively acknowledged that after asking, they were presented with special videotaped instructions on the experiment. The second part of the teaching block – practical training in the use of alternatives (i.e. *in vitro* cytotoxicity assessment on cells cultured *in vitro*) was positively accepted by 75% of respondents.

When all these responses are taken into account, it is clear that students themselves consider teaching of alternatives to laboratory animals at our faculty as fully acceptable. Students were asked to use the same grading system as in high school to evaluate our teaching module on alternatives; 88% of students labelled this module as excellent or very good.

In the next section of the questionnaire we tested our students' knowledge on alternatives. Virtually all students were able to describe the exact meaning of the 3Rs. 68% of respondents knew that experiments on animals should be probed by the national committee for the use of animals and not by the head of department or the dean. When asked to enumerate types of alternatives to laboratory animals in education, the students displayed less knowledge. The vast majority of students correctly named computer models and cells cultured *in vitro* as examples of alternative teaching models, but only 23% of respondents correctly noted the third possibility – non-invasive experiments on volunteers.

In the last part of the questionnaire students could add personal comments about the use of laboratory animals at our faculty or put down some suggestions for improving the situation. This opportunity was used by only 50% of respondents, and their opinions differed greatly. One explanation for this may be that comments and suggestions came from students with well-defined standpoints only. Generally, students recommended small working groups, extended time for practicals, more animals, or, alternatively, complete replacement of animals. The main advantages mentioned in connection with the use of laboratory animals were: visualisation, first contact with living animals, elimination of the fear of "cutting a living creature", authentic experience, etc. Only in a few cases did the students acknowledge the opportunity of being informed about scientific methodology.

Being teachers, we can be very pleased with the fact that students appreciate it when teachers try to minimise the suffering of animals, work very carefully with animals and organise practical work well.

Few students stated that they had had a negative experience – not properly effected anaesthesia or insufficient experience of some assistant teachers. There were clearly differences between students of different study groups who had different teachers. To rectify this situation, we will have to pay more attention to harmonisation of skills and attitudes of individual teachers.

Conclusions – future trends

Nowadays, the situation at our faculty is stabilised and the use of laboratory animals in education is very limited (about 20 rats per year). We have implemented international standards in husbandry and care for laboratory animals and the obligatory regulations for experimentation with animals are accepted. Non-animal alternatives are available and students can choose between animal and non-animal alternatives during their practical lessons. All students have to pass the obligatory teaching module about alternatives to animals and receive balanced information on the proper use of laboratory animals and advantages and disadvantages of alternatives in a harmonised teaching module.

In the future, we will emphasise not only ethical issues but also scientific merits. We believe, that there are many good scientific reasons to replace some animal experiments with some *in vitro* methods. However, the same point of view will dictate that some animal experiments, which are indispensable from the scientific standpoint, will remain. In light of our current experiences, one question remains open: Is animal-free teaching at medical faculties the ultimate goal, or are very limited experiences with living animals essential for students of medicine?

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University of Virginia Medical School Replaces Canine Lab with Human Patient Simulator

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Summary
Until recently, the University of Virginia School of Medicine (UVa) taught emergency surgical procedures using a canine laboratory. Medical students, working with faculty, administration, and community members, eliminated the use of canines and implemented a new life-saving techniques course using a human patient simulator and other stand-alone stations, allowing students to practice repeatedly without using animals. Replacement of this canine lab marked a turning point for medical education at UVa, and follows a general trend since 1994 of declining use of animals in medical education in the U.S.

Keywords: replacement, medical education, live animal labs, surgical training, human patient simulators

Introduction

Live animal laboratories were traditionally used for basic skills training in physiology, pharmacology, and/or surgery in the medical school curriculum. In 1985, virtually all 126 medical schools in the U.S. offered a live animal laboratory as a requirement for physicians-in-training. Medical students, depending on the exercise, injected drugs such as epinephrine, into an anesthetised animal and monitored physiological responses such as heart rate and vascular tone. Medical students also practiced surgical skills, such as suturing, IV placement, and chest tube insertion on anesthetised animals. Canines were typically used and the animals were euthanised at the end of the laboratory. Between 1985 and 1994, a decline in animal use in medical education was seen (Ammons, 1995; Wolfe et al., 1996). A continuation of this trend was demonstrated in a 2001 survey in which 68% of U.S. medical schools had eliminated live animal laboratories for student training. Furthermore, when animal laboratories were offered, participation was optional in most cases (Hansen and Boss, 2002). Recent surveys conducted by the Physicians Committee for Responsible Medicine (PCRM) indicate that over 80% of U.S. medical schools have eliminated all live animal laboratories from their curricula (unpublished data). The remaining 20%, although not requiring participation, still offer live animal labs to civilian medical students. The dramatic decline in animal use over the past 15 years has been attributed to the cost of using animals, curricular expansion, and ethical concerns (Hansen and Boss, 2002).

The University of Virginia (UVa) School of Medicine in Charlottesville offered a canine laboratory to 3rd year medical students for training in emergency surgical skills. Our approach was to promote one R, *replacement*, of the 3Rs concept of *replacement*, *reduction* and *refinement* of animal use in education. We worked with the community to eliminate the outdated canine labs from the undergraduate medical curriculum at UVa and to replace them with superior, non-animal training methods.

Alternatives to live animal laboratories in medical education

Animal use in education is undoubtedly an ethical issue, and guidelines set forth by U.S. Institutional Animal Care and Use Committees state that alternatives to the use of animals in education are to be considered and used when available (National Research Council, 1996). Over the past decade, advances in computer software and simulation technologies have fostered the development of numerous, high-quality alternatives to animal laboratories for medical training. In addition to videos and ethically-sourced cadavers, virtual reality programmes and simulation models provide training that is humane, clinically-relevant, and more realistic than animal laboratories. The advantages of using human-based training methods include anatomical accuracy, the ability to achieve proficiency through repetition of procedures, a realistic clinical environment (Gordon and Pawlowski, 2002), and long-term cost savings.

Alternatives for basic skills training in physiology, pharmacology, and surgical skills are numerous and widespread. Medical physiology can be taught using interactive computer programmes in which students are able to monitor changes in physiological parameters, such as blood pressure and heart rhythms after administration of "virtual" drugs. One study compared student test scores for a physiology laboratory when using videodiscs or when using live animals and found no difference in scores between the two training methods (Fawyer et al., 1990). Another group compared computer-based training to animal laboratories for cardiovascular physiology and showed that students favoured computer-based training (Samsel et al., 1994).

These studies corroborate data from a survey of U.S. medical schools which shows a 50% decline in the use of live animals in medical school physiology and pharmacology from 1994 to 2001 (Hansen and Boss, 2002). Although the decline in live animal use in medical education overall is significant, the use of live animals in surgery courses was stable from 1987 to 2001 (Hansen and Boss, 2002). Recent surveys conducted by PCRM indicate that animal use for surgical training is declining and a number of studies demonstrating improved student performance of surgical skills using alternatives versus live animals have been conducted (McCarthy et al., 2002; Tsang et al., 1994). Moreover, in countries such as the UK, live animal use for the practice of surgical techniques has never been a tradition (Jukes, 2004). Instead, human anatomical simulators and/or perfused organ systems allow students to practice surgical techniques on anatomically accurate models with simulated blood flow. In addition, student self-assessment and clinical practicals are useful adjuncts that replace animal laboratories.

Chronology of events to replace the canine laboratory at UVa

Upon learning that the majority of US medical schools had eliminated terminal live animal laboratories from their curricula, medical students at the University of Virginia sought to replace their canine laboratory with humane, non-animal methods as well. The University of Virginia offered a "Life-Saving Techniques Laboratory" course to 3rd year medical students, in which emergency surgical skills were practiced on 96 beagles per year. The students were shown each of the following procedures once: chest tube insertion, venous cut-down for intravenous line placement, cricothyroidotomy, and splenectomy. Although the laboratory course was optional, the instructor described the laboratory as "one of the best experiences students will have in medical school." Conscientious objectors to the use of live animals for this purpose were given an opportunity to opt out of the lab only hours before the start of the lab. The procedure used by the course directors to identify such students was to have them raise their hands in front of the entire class. This intimidating environment, and the lack of opportunities to use alternatives, may have caused some medical students at UVa to fear academic consequences or embarrassment for not participating in the animal laboratory.

Efforts to replace the canine laboratory were initiated in October 2002 by a veterinary technician responsible for the care of the beagles. Comments from a few medical students regarding their unpleasant experiences with the canine laboratory prompted the veterinary technician to send an e-mail to first and second year UVa medical students about alternatives to the use of live animal laboratories. A canine laboratory was scheduled for January 2003 and third-year medical students were informed of the lab only 2 weeks prior to the start. Two medical students organised a presentation for January 31, 2003, entitled "Alternatives to Live Animal Use in Medical Education", given by Neal Barnard of PCRM. One hundred and fifty people, mostly medical students, residents, and faculty, attended the presentation. Lengthy discussions about the scientific and ethical concerns surrounding live animal labs followed. The University newspaper, *The Cavalier Daily*, published a front page story about student opposition to the canine laboratory, as well as letters to the editor, both in support of and in opposition to the animal lab.

The canine laboratories continued until August 2003, when two medical students presented the instructor of the "Life-Saving Techniques Laboratory" course with a list of alternatives for surgical skills training. Third year medical students in the surgical clerkship were asked their preference for a human cadaver lab or a canine laboratory; 50% of the students (n=18) indicated a preference for a human cadaver lab, 25% (n=9) preferred a canine laboratory, and 25% (n=9) had no preference either way. During the next session of the course, the instructor made arrangements for only 4 students to learn the procedures on a single human cadaver. No human cadaver alternative was offered after that initial lab, even though the 4 students that completed the lab had overwhelmingly favourable comments about their experience.

The continued failure of faculty and administration to permanently implement alternative training methods at UVa prompted medical students to organise another presentation on alternatives to animal use. In October 2003, a trauma surgeon presented various training methods for emergency surgical procedures that do not rely on animal use. This talk was countered two weeks later with a presentation by the course director justifying the use of canines for trauma training. Medical students and concerned citizens in the community formed an advocacy group called Citizens for Humane Medicine in November 2003. They began contacting the media to increase community awareness of this lab in an effort to replace it with more modern and effective training methods.

In January 2004, the local newspaper, *The Daily Progress*, printed a front page story describing the efforts of Citizens for Humane Medicine (CHM) to eliminate the canine laboratory. Media coverage of CHM's efforts continued for several weeks, followed by phone calls from community members supporting the replacement of the canine labs. In February 2004, the Dean of the Medical School announced a suspension of the canine labs pending a review by a newly formed committee. The 12-person committee, comprised of faculty, residents, and one medical student, voted to permanently eliminate canine laboratories in March 2004. The committee also recommended that alternative training methods be implemented similar to those being used at most other U.S. medical schools.

Results

A new, full-day course entitled "Life-Saving Techniques Workshop" was implemented by the Emergency Medicine Department in November 2004 to replace the canine lab that was previously conducted by the Surgery Department. The new course uses six workstations to teach emergency procedures. These include chest tube insertion, adult and paediatric airway intubation, surgical cricothyroidotomy, and vascular access in

various anatomical locations. Lastly, a human anatomical simulator called Human Patient Simulator™ (HPS; METI, USA) was purchased to give medical students a realistic environment in which to identify life-threatening situations and perform life-saving procedures (Gordon, 2000).

Conclusion

Replacement of canine surgical laboratories at UVa follows a general trend of declining animal use in U.S. medical education over the past 20 years. Efforts to eliminate crude animal laboratories for educational purposes at UVa took approximately two years. The involvement of dedicated medical students and community members was critical to its success. The surgical faculty at UVa were not amenable to the implementation of non-animal training methods, in spite of the availability of suitable alternatives and their use by over 80% of medical schools in the U.S. Ultimately, public pressure through sustained media coverage forced UVa to re-evaluate its curriculum. The result was to replace its canine laboratory with a superior, non-animal training method. We believe the strategies employed at UVa can be used as a guide for replacing animal laboratories at other medical schools and in other educational settings to achieve the goals of the 3R's concept of animal use.

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RECAL: Creating Computer-assisted Alternatives Using a Sustainable Learning Objects Approach

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Summary
The mainstay alternatives to using animals in higher education are multimedia computer-assisted learning (CAL) programmes simulating practical pharmacology classes. CAL development intrinsically ties the educational content and learning design to the authoring application. As technologies change, authoring applications become obsolete, leaving redevelopment at further expense as the only option.
RECAL is based on principles of standards, objects and reusability and is developing methods and tools to break this cycle by disaggregating existing CALs to separate their constituent learning objects from the runtime environment. This has improved their long-term viability and facilitated their adaptation by teachers to meet divergent learning needs.

Keywords: computer-assisted alternatives, pharmacology teaching, higher education

Introduction

Over the last twenty years the mainstay of technology-supported teaching and learning in the biomedical sciences has been interactive multimedia computer-assisted learning (CAL) programmes designed to support specific areas of the curriculum. In pharmacology and physiology a number of these programmes have been aimed at laboratory teaching of these subjects that typically use animals or animal tissues. In such cases the CAL programmes provide an alternative to the educational use of animals and are very much consistent with the 3Rs and replacement in particular. Although they are not the only form of alternative (see Gruber and Dewhurst, 2004 for a more detailed account), they are the major form of alternative available to teachers who use animals in teaching of pharmacology, probably the discipline that is the major user of animals in education. To be effective in reducing animal usage they must be acceptable to educators – computer-assisted alternatives must be shown to be educationally effective, they must meet the learning objectives of the laboratory session they were developed to replace, they must be able to be delivered to students in locations in which learning takes place and they must be low-cost. A number of studies have evaluated the effectiveness of e-alternatives. These suggest such resources are able to deliver low-cost, effective education that meets primary teaching and learning goals (Dewhurst, et al., 1994; Hughes, 2001; Fawver, et al., 1995; Guy and Frisby, 1992; Leathard and Dewhurst, 1995).

There is now a critical mass of high quality e-alternatives available to teachers (see www.eurca.org for a list of independently reviewed programmes) and many universities across the world have now substituted at least some animal experiments in their curricula. Most of the computer programmes currently available were developed in the 1990's and are marketed to universities in CD-ROM format. In most instances universities copy the programmes to their institutional server(s) and deliver the programmes to students across their local area network (LAN). With the now near ubiquity of the Internet and a shift to more (off-campus) student-centred learning activity in higher education, there is increasing demand to be able to access learning resources via the World Wide Web.

The fact that there is widespread availability of computer-based alternatives that have been demonstrated to be educationally effective and have received good independent reviews does not necessarily mean that teachers will actually use them and thereby reduce animal use. The usefulness of a CAL programme depends on the closeness of fit of the programme to the needs of the teacher and his or her willingness to adopt materials developed elsewhere. It is unlikely that teachers will find programmes that meet all of their needs. Anecdotally at least, many teachers want the opportunity to be able to tailor these programmes to meet their local context of use. Thus for instance, in a pharmacology simulation programme they might wish to add new or delete some of the test drugs, extend the dose range, add new tasks or delete current ones, display the data in a different format (e.g. extend the time base), translate the text into a language other than English, add formative assignments, etc. Similarly, small clips from videos of animal dissection or anatomy might be more useful and usable than the whole presentation. To date, the intrinsic constraints of the authoring tools used to create the alternatives make this editing process very difficult and expensive: editors would have to acquire the original programme's source code, purchase the appropriate authoring software, and they would need to find staff with the skills, time and experience to change the resource to meet their requirements. The redevelopment process would then be repeated at every university that needed a variation of the original CAL programme.

From this it is clear that today's educators require editable, web-based learning materials – properties which are not consistent with the LAN-based multimedia CD-ROMs of the last decade when programmes were developed using commercial

authoring programmes (such as Toolbook (Asymmetrix), Authorware (Macromedia) and Director (Macromedia)). The product was a compiled executable programme containing all of the learning and media assets (text, images, graphics, animations, video, audio, self-assessment questions), the sequencing of these assets, and the learning design. The educational content was therefore intrinsically linked to the technologies used to develop and deliver the programmes. Technology has changed rapidly (such as the move from DOS to Windows, from 16 bit to 32 bit processing and from VGA to XGA and above screen resolutions) and it continues to change. This ongoing flux means that while the educational content and learning design of a programme may still be valid, it too may be lost as its delivery mechanism becomes obsolete.

The RECAL project described here is developing methodologies that make use of new ways of abstracting and managing the educational content (assets), pedagogical design and run-time components of existing e-alternatives to allow for much greater longevity and flexibility of such materials. Here we present an introduction to the RECAL approach, its use of common standards and specifications to describe assets and educational activities and how it can 'future-proof' CAL materials and thus benefit both developers and users.

Methods: the RECAL process

The RECAL architecture

The RECAL process fuses new fast and light web-based multimedia technologies such as Macromedia Flash to develop the content with the use of XML and is based on common learning technology standards and specifications. Semantically-rich XML (extensible mark-up language), which can be saved as cross-platform text files and can be created and transported rapidly between applications, is used to encode and thereby preserve the content and design of CAL materials. This can, as a result, expand their lifespan significantly and enable more effective reuse.

The RECAL architecture is based on a number of disassociated components (the run-time engine (currently Flash), the text (XHTML files) and media assets which are stored on a web-server and the XML parameter files describing the sequencing), each of which can be modified independently of the others. When the user starts the programme these components are assembled and presented dynamically: the runtime engine looks for the XML parameter file and, finding it, loads the instructions and content specified in the XML. Some of these specifications are URL pointers to external resources such as images, animations, data traces, text and questions that are dynamically loaded in to the runtime programme as well.

Any one of the components can be changed independently of any of the others – images or text can be added or edited, sections of the CAL programme can be extended, the programme can be translated into any number of different languages or a different runtime engine could be used. In this situation, changes to the XML file would point at a different set of text and media assets as local circumstances dictate. While Flash currently provides the runtime engine of choice, the emergence of a new runtime technology in a few years would not create problems, as the XML sequence and the media assets are managed separately and would simply be plugged in to the new runtime engine. RECAL is also developing a web runtime engine.

The RECAL process

The RECAL process comprises a number of stages.

Disaggregation

RECAL is working with an existing set of CAL programmes developed by the author (DD) and now marketed through Sheffield BioScience Programmes (www.sheffbp.co.uk). These CAL programmes are pedagogically sound and it is important that the assets and learning design encapsulated in them are not lost simply because the runtime engine has become or is likely to become obsolete. Part of the RECAL process is to unlock the content and release the media assets such as images, diagrams and animations, information assets such as text, data and algorithms, and learning activity designs such as the structure, organisation and rules the CAL programmes contain. In some cases the CAL programmes are available in an uncompiled form, which allows direct access to these components; in others the components have to be extracted by taking screen-grabs, transcribing text and by recreating those components where no direct extraction is possible. Animated sequences, diagrams and photographs usually need to be recreated, either because the animation is inextricably tied to the particular authoring tool used or because they do not meet contemporary standards of quality. At the end of the disaggregation process we are left with: text (XHTML), images (JPEG), dynamic animations and images (SWF), questions (IMS QTI XML) and parameter files describing the sequencing (IMS SS XML).

Asset (learning object) management

Disaggregation of each CAL programme can release in excess of 100 assets, each of which needs to be managed independently of the others. Each asset is catalogued; this associated metadata describes its basic properties and includes file type, location, keywords, intellectual property rights, provenance, location, and size. The asset and its metadata are managed in a learning object repository, designed to specifically hold and manage learning object metadata (using the IEEE 1484 Learning Object Metadata standard).

Pedagogical design

The pedagogical design of the original CAL programmes is rendered in XML using IMS Simple Sequencing specification. IMS Simple Sequencing, in that it consists of ways to describe a learner's progress and interactions, is most like traditional CAL programmes, with sequencing rules covering aspects such as branching or conditional advancement.

Run-time engines

The run-time engine (an application that renders the presentation elements and manages user input) has to be able to read the XML parameter files, call down the appropriate resources from

the repository and provide the interface for the user. RECAL has decided to use Macromedia Flash for its standalone run-time shell but is also testing web rendering in plain text to support users with visual disabilities.

Authoring tools

The creation of easy-to-use, template-based authoring tools will enable non-technical teachers to assemble their own learning activities from the disaggregated assets. The goal is to provide teachers with an editor that lets them customise all aspects of the CAL programme for their local needs. This customisation may include the reorganisation, addition or removal of sections, images, text, or questions, changing things such as drug dose, drug names or electrical stimulation parameters. The tools could also be used to create different language versions. At its core, the authoring tool will create XML text files for the run-time engine to use and will use a simple graphic interface to support the majority of authors who will be unfamiliar with XML.

Results

RECAL pilot

A proof-of-concept pilot of this staged process was completed in the autumn of 2003. A Flash run-time was constructed that could dynamically load and render an external XML parameter file and the resources it identified. The pilot only involved one CAL programme, an English-language version of a programme originally developed for DOS, later rewritten for early versions of Windows using Assymetrix Toolbook version 2.0 and redeveloped again in 1998 for later versions of Windows using Macromedia Director. The programme was disaggregated and the XML was assembled in a text editor.

The pilot's short development cycle has raised a number of technical implementation issues:

templates for different types of screen/page types, which support different types of interaction, need to be developed, e.g. data display screens, multiple choice question screens, information screens.

Navigation often needs to be simplified and now uses common web-browser icons e.g. the Home button and the back/forward buttons closely resemble those used in Microsoft's Internet Explorer.

The tools are being developed and evaluated in-house with the purpose of tailoring the pilot application for non-technical teachers.

Supporting simulations of experiments

Multimedia CAL alternatives to using animals in teaching pharmacology and physiology are broadly of two types:

CAL simulations of pharmacology experiments typically present data traces for a number of key experiments designed by experienced teachers to meet identified learning goals. Students have limited control over the design of an experiment. These programmes often include significant background information, self-assessment questions designed to test accuracy of data recording, data interpretation, knowledge of underlying principles, etc. This approach would be analogous to the learner using a tutor-designed schedule to perform a series of defined experiments on a pharmacological preparation where the teacher defines the experimental parameters such as which drugs/drug combinations, drug-dose range to try to ensure that the experiment is successful and the learning goals are achieved.

CAL simulations of preparations that are algorithmically-driven and try to put the learner into a situation where he or she is provided with a pharmacological preparation and a number of test drugs. The learner must design experiments to meet certain learning objectives and must choose experimental parameters such as drug dose, drug combination and other experimental parameters.

Both approaches have merit and different learning objectives will be achieved. The majority of the programmes available to the RECAL project are computer simulations of experiments and much of the development has focussed on this approach. However, if RECAL is to have wider applicability, it needs to be able to handle algorithms that create simulated data. Although this has not as yet been tested, it should be possible for RECAL to handle more complex interactions such as algorithmic simulations.

Discussion

This paper has described the RECAL approach to extending the life of a number of existing computer-based alternatives. It has the potential to provide teachers and courseware developers with a mechanism for salvaging good pedagogical content from CAL programmes that have reached or are nearing technological obsolescence. The disaggregation process releases the components or assets and the educational designs that constitute these CAL programmes and makes them available for reuse via a repository into which all of the component learning assets are catalogued.

Abstracting the learning assets and the educational design from the run-time engine approach is also recommended as a method for new developments. The 3 year project is very much work in progress and is now at mid-point. The results of the proof-of-concept pilot are very encouraging and about 60% of the computer programmes available to the project have been disaggregated, yielding in excess of 1000 learning assets ranging in complexity from text, images and data traces to interactive diagrams and questions and animated graphics.

The development of easy-to-use, template-driven authoring tools will empower teachers to create their own learning activities rather then being reliant on the expertise of a courseware developer. These same tools will enable teachers to edit existing computer simulations, which have been developed using the RECAL methodology, to meet their local learning needs and circumstances.

Although the process has been developed specifically for an existing range of computer simulations, it could be applied to any multimedia CAL programme in any discipline. The opportunity that this approach offers to an institution to enable it to better manage valuable teaching and learning resources more effectively should also not be overlooked.

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The InterNICHE Policy on the Use of Animals and Alternatives in Education

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Summary
The InterNICHE "Policy on the Use of Animals and Alternatives in Education" is a comprehensive document in 10 sections that addresses all aspects of work with animals and alternatives in life science education. The Policy presents guidelines to ensure effective and fully ethical acquisition of knowledge and skills. It includes a definition of alternatives in education and of harm, and presents individual policies on dissection, the sourcing of animal cadavers and tissue, work with live animals for clinical skills and surgery training, and ethical field studies. It also addresses the use of animals for the production of alternatives. While the ideal "replacement alternative" is defined as "non-animal" within the 3Rs philosophy of Russell and Burch (1959), the Policy highlights a shortcoming of this approach for education. Not only is there a requirement for some students to work with animals, animal tissue and clinical procedures in their education, there is widespread evidence of the ability to fully meet all teaching objectives in ways that are neutral or beneficial to individual animals and that do not involve animal experimentation or killing. As well as non-animal learning tools, like multimedia computer simulation, digital video, training models and mannequins, replacement alternatives also include the use of ethically-sourced animal cadavers for dissection and skills training and apprenticeship into clinical practice with animal patients. Definitions of "ethically-sourced" and of ethical educational opportunities within clinical work are included in the Policy, which demonstrates the possibilities for full replacement of harmful animal use in education.

Keywords: alternatives, animal experimentation, clinical, dissection, education, ethically-sourced, field studies, InterNICHE, teaching objectives, harm, policy

Introduction

The InterNICHE Policy on the Use of Animals and Alternatives in Education (Jukes and Chiuia, 2003) presents comprehensive guidelines in 10 sections that address all aspects of work with animals and alternatives in life science education. The Policy reflects the InterNICHE commitment to full replacement of harmful animal use whilst supporting effective acquisition of knowledge and skills.

Beginning with the InterNICHE Position Statement, a definition of alternatives in education and a definition of harm, the document presents individual policies on a range of issues including dissection, the sourcing of animal cadavers and tissue, work with live animals for clinical skills and surgery training, and field studies. It also addresses the use of animals for the production of alternatives.

Why is a policy necessary?

A policy provides a considered opinion on an issue or practice and through its guidelines can facilitate transformation towards best practice. It is important for organisations to have a clear position with respect to all aspects of their field of focus in order to effectively communicate their vision and practical strategy and to optimise the positive impact of their work. The InterNICHE Policy provides a detailed exploration of the ethical and practical issues inherent in the use of animals and alternatives, and envisages and facilitates the creation of a fully humane education so that the teaching objectives of practical classes can be met in the most ethical and effective ways.

The process of curricular design and the selection of learning tools in life science education involve choices by decision-makers that always have an ethical dimension. The Policy clarifies the ethical impact of the different uses of animals and alternatives, states what is and is not acceptable according to InterNICHE, and makes clear the possibilities for enhancing the quality of education.

The Policy provides a base for developing and modernising regulations and legislation concerning the use of animals and alternatives in education, from the level of a university department to national and international law. It also helps individual students and others to clarify and reflect on their ethical positions and encourages capacity-building in ethical decision-making and practice.

Contents of the Policy

The 10 sections of the Policy are:
1. Position statement
2. Definition of alternatives in education
3. Definition of harm
4. Policy on animal dissection
5. Policy on ethical sourcing of animal cadavers and tissue
6. Policy on other sources of animal cadavers and tissue

7. Policy on live animal use for clinical skills and surgery training
8. Policy on live animal field studies
9. Policy on the ethical use of live animals, animal cadavers and tissue for making alternatives
10. Policy on other use of live animals, animal cadavers and tissue for making alternatives

Each of the sections is briefly described below.

1. Position statement

InterNICHE supports a high quality humane education within the life sciences and the use of alternatives to meet teaching objectives. InterNICHE is against all harmful use of animals in education, including the harming and killing of animals for their cadavers and tissue, for live experimentation and skills training, for ethology and field studies and for making alternatives.

2. Definition of alternatives in education

Alternatives are humane educational aids and teaching approaches that can replace harmful animal use or complement existing humane education. Alternatives may be non-animal alternatives or approaches that involve neutral or beneficial work with animals. They comprise:

- Film and video
- Models, mannequins and simulators
- Multimedia computer software and virtual reality (VR)
- Ethically-sourced animal cadavers and tissue
- Clinical work with animal patients
- Student self-experimentation
- *In vitro* labs
- Field studies

Many of the above will be recognised as part of educational best practice, and in some countries, humane approaches within certain disciplines are tradition. "Alternative" teaching approaches – by tradition or by modern choice – are therefore often the norm. For example, the training of veterinary students involves direct experience with real patients in all primary veterinary colleges, and it is undertaken as part of the provision of clinical care by faculty clinicians or private practitioners. However, in some colleges and some countries, students still typically use laboratory animals for clinical skills and surgery training and may have little or no access to the learning opportunities available with clinical work on patients. Developing significantly greater student access to such clinical work is therefore an "alternative" to the use of laboratory animals. Similarly, other tools and approaches listed above are used widely by teachers but can all be considered as alternatives where harmful use of animals continues.

The majority of life science students will enter professions that do not involve work with animals, and well-designed combinations of non-animal learning tools can successfully meet the teaching objectives in their practical classes. This leaves the privilege of working with animals to students of veterinary medicine, zoology and other fields in which there is a requirement for students to be familiar with animals, animal tissue and clinical procedures. Such experience can be achieved in ways that are neutral or beneficial to the well-being of individual animals and that do not involve laboratory animal experimentation or killing.

As the ideal "replacement alternative" is defined as "non-anima"' within the 3Rs philosophy of Russell and Burch (1959), the Policy therefore also highlights a shortcoming of this approach for education: despite the widespread success and further potential for replacement of harmful animal use by non-animal alternatives, the latter are not sufficient for full knowledge and skills acquisition in certain areas of education. Veterinary surgery is one example where thorough training with non-animal alternatives must be followed by hands-on experience with living animals. However, this does not suggest a necessity for conventional training using laboratory animals. Instead, it suggests that approaches that are neutral or beneficial to individual animals, such as clinical work with patients, are the ideal replacement alternatives. This full replacement of all *harmful* animal use, rather than of all work with animals, is the appropriate solution to many of the pedagogical, ethical and practical challenges facing life science education. The Policy has a significant focus on the ethical use of animals in order to address this issue.

3. Definition of harm

Integral to discussions about harmful animal use and alternatives is the definition of harm. While there may often be agreement on whether a certain practice or procedure is harmful to an animal and efforts are made to assess the degree of that harm, disagreements and individual and cultural differences in such assessments remain. For example, is killing a form of harm? Is an experiment performed under general anaesthetic harmful? Is isolating an animal from others of his/her species harmful?

According to the Policy, harm comprises any action, deliberate or otherwise, that impinges on an animal's current and future well-being by denying or limiting any of the following freedoms:

- Freedom to live
- Freedom to express full natural behaviour
- Freedom to be part of a social structure and ecosystem
- Freedom from hunger and thirst
- Freedom from discomfort
- Freedom from pain, injury and disease
- Freedom from fear and distress

This is a strict definition of harm, but it reflects its serious nature. Moreover, case studies of full replacement of harmful animal use demonstrate that the exacting demands of the Policy can indeed be met (Kumar, 2003; Smeak, 2003).

Harm caused to an animal within education is only acceptable when it is the unavoidable consequence of action taken to benefit the individual animal, and in certain circumstances when the action is taken to benefit the species or to produce an alternative, given that the harm inflicted is only brief and minor. In these cases, cost-benefit analyses concerning harm and potential benefit to the individual animal, the species and to other animals should be conducted.

4. Policy on animal dissection

Animal dissection can be a useful tool for knowledge and skills acquisition and may encourage an appreciation of life, when all

8 conditions described in this section of the Policy are met. Three of these conditions are described below:

4.1 The animal cadaver is ethically-sourced (see section 5 below).

4.2 The dissection is performed at university level and no lower.

4.3 The dissection is relevant for the student's career.

The majority of dissections performed at universities are of animals killed for that purpose, and such use is not acceptable.

5. Policy on ethical sourcing of animal cadavers and tissue

InterNICHE is against all harmful use of animals in education, including the harming and killing of animals for sourcing of cadavers and tissue. As illustrated by the dissection examples above, however, such material may provide a useful resource for knowledge and skills acquisition. The use of an animal cadaver or tissue is acceptable when it is ethically-sourced, and it may be recognised as such when all 9 conditions in this section are met. The first three state:

5.1 The animal was not captured, bought, bred, kept, harmed or killed to provide the cadaver or tissue.

5.2 The animal was wild, stray, or a companion animal before death.

5.3 The animal died from natural causes or an accident, or was humanely euthanised secondary to natural terminal disease or serious non-recoverable injury.

Animal cadavers and tissue are usually obtained from sources where animals suffer harm or are killed, such as animal breeders, research facilities, some animal shelters, farms, slaughterhouses and sporting events. The Policy does not consider material from these sources, including so-called "waste" or "surplus" material, to be ethically-sourced: its ethical nature has been compromised or negated by the harming, killing and/or marketing of the animal at some stage of his/her life.

The condition in this section and elsewhere in the Policy that the animal must be a wild, stray, or companion animal is to ensure that the animal was free-living in origin rather than bred and/or kept for use. The reference to euthanasia refers to the true meaning of the word: ending the life of an animal that is suffering from terminal illness or an incurable condition, based on the interests of the animal. Despite its necessity, euthanasia is referred to in the Policy as harmful, because taking of a life is a significant form of harm.

The following examples of source and use of animal cadavers and tissue further illustrate the Policy:

First, anatomical dissection of frogs collected from the wild and sold by a biological supply company: As the frogs were captured and killed, the cadavers are not ethically-sourced and such use is not acceptable.

Second, surgical dissection by veterinary students of companion animal cat and dog cadavers sourced from a veterinary teaching hospital: If the animals died from natural causes or in accidents or were euthanised for the reasons stated in 5.3 (above), then the cadavers are ethically-sourced and such use is acceptable. Dogs killed in shelters due to inability to rehome them are not ethically-sourced because they do not meet the conditions of 5.3.

Third, mitochondria from the livers of rats sourced from research laboratories: As the animals are laboratory animals and not wild, stray or companion animals, and moreover were killed rather than euthanised, the tissue is not ethically-sourced and such use is not acceptable. Tissue from companion animal rats is ethically-sourced if all conditions are met.

6. Policy on other sources of animal cadavers and tissue

In non-ideal circumstances, cadavers and tissue from species of animal that are less common as wild, stray or companion animals may be hard to source ethically. This may be the case in some countries at certain times. Deriving animal cadavers and tissue from other sources such as research facilities, slaughterhouses or farms is therefore an acceptable compromise when all 8 conditions in this section are met. The first three state:

6.1 Animal cadavers or tissue are genuinely required for practical work or for making an alternative, and no ethically-sourced and appropriate material is available.

6.2 The animal was not captured, bought, bred, kept, harmed or killed to provide the cadaver or tissue.

6.3 The animal has died from natural causes or an accident or was humanely euthanised secondary to natural terminal disease or serious non-recoverable injury; or the cadaver or tissue is destined for disposal or has been abandoned by the animal.

Genuine waste from the above sources is therefore acceptable under certain conditions. Material other than genuine waste is not acceptable, because it helps to create a demand for animals from such sources, which contributes to further harming or killing. So-called "surplus" animals deriving from research facilities and sometimes used in education are an example of what is not acceptable.

7. Policy on live animal use for clinical skills and surgery training

The use of live animals in the clinical setting is an integral part of knowledge and skills acquisition for veterinary students. It is acceptable when all 14 conditions in this section are met. First, in contrast to the conventional instrumental use of animals, the Policy states:

7.1 Opportunities for clinical skills and surgery training are built around the needs and well-being of individual wild, stray and companion animal patients, and healthy companion animal volunteers.

Such an approach is described in detail by Rasmussen (2003).

Although much clinical skills and surgery training involves no harm to animals, further conditions in this section explore the issue of harm and the performance of terminal procedures.

7.5 Harm caused to an animal patient during a clinical procedure and/or treatment is acceptable when it is the minimum harm necessary for successful work aimed at healing the animal; and in certain circumstances during procedures involving an animal that is suffering from natural terminal disease or serious non-recoverable injury; or when it comprises the act of humane euthanasia.

7.6 Clinical skills and surgery training that involves a ter

minal procedure is acceptable only when an animal is suffering from natural terminal disease or serious non-recoverable injury; and for whom a decision to euthanise has been made by a qualified veterinarian with the consent of the animal's guardian (if any), based on the interests of the animal and not motivated by practical or financial interests.

7.7 Harm caused during an invasive and/or terminal procedure on an animal that is suffering from natural terminal disease or serious non-recoverable injury is acceptable only when the harm is not subjectively experienced by the animal; and when it comprises the act of humane euthanasia.

Other conditions in this section help ensure that live animal use is acceptable: appropriate training and competence of the instructors; supervision and sufficient skills mastery of the student; respect for the student's ethical position; respect for the animal; high welfare, health and safety standards; and open ethical discussion in the classroom. All are necessary conditions for work with live animals in the clinic. Some of these conditions are repeated in other sections of the Policy.

8. Policy on live animal field studies

The educational study of free-living wild or stray animals is a valuable experience, acceptable when all 14 conditions in this section are met. The first four state:

8.1 Opportunities for field studies are built around the needs and well-being of individual wild and stray animals, animal species, and the ecosystem.

8.2 The animal is not captured, bought, bred, kept, harmed or killed for the purpose of the study, except for capture and/or harm in certain circumstances that are beneficial to the individual animal, species or ecosystem.

8.3 Field studies should cause zero or minimal disturbance to an animal, his/her social structure and the ecosystem; or have a beneficial impact on an animal, species or ecosystem.

8.4 Capture and/or harm caused to an animal are acceptable only when the animal is a patient, or will benefit from a clinical procedure; and in certain circumstances for the benefit of the species or ecosystem.

The potential for ethical field studies is described by Bekoff (2005).

Other conditions in this section clarify that harm caused to an individual animal for the benefit of the species or ecosystem is acceptable only if minor and temporary; and state that field studies should avoid threatened species and ecosystems unless the likely benefits outweigh the costs; and refer back to sections of the Policy on sourcing of animal cadavers and tissue, on live animal use for clinical skills and surgery training, and on the use of live animals, animal cadavers and tissue for making alternatives (see below), when field studies involve these aspects.

Two examples illustrate the Policy. First, temporary capture and tagging of a wild animal for ethology studies that will support the protection of the species and the ecosystem: As long as the individual animal's future well-being is not jeopardised by the capture and tagging, this is acceptable. Second, temporary capture of feral cats to study lineage and genetics: This is only acceptable if the individual animals will also benefit from clinical attention.

9. Policy on the ethical use of live animals, animal cadavers and tissue for making alternatives

Animals are also used for the production of alternative tools, such as videos or software for virtual dissection and virtual experimentation. Typically, this involves harming or killing animals, and such use is not acceptable. Data generation in virtual experimentation can in some cases be achieved using mathematical algorithms. However, in other cases the use of a live animal or an animal cadaver or tissue for making an alternative may be considered necessary. Such use is acceptable when all 7 conditions in this section are met. The first two state:

9.1 An alternative for the practical does not already exist or is not practicably available.

9.2 The animal is not captured, bought, bred, kept, harmed or killed for the purpose of making the alternative, except for harm and/or euthanasia in certain circumstances during procedures involving invasive and/or terminal live animal use.

Other conditions re-iterate sections of the Policy that address the use of animals, and apply them to the context of making alternatives. These include sections of the Policy on sourcing of animal cadavers and tissue, on live animal use for clinical skills and surgery training, and on live animal field studies, when these aspects are used to make alternatives.

One example illustrates the Policy, particularly the issue of harm in 9.2. Filming a terminal surgery on an animal that is facing euthanasia in order to make a needed alternative: If the decision to euthanise was made by a qualified veterinarian, based on the interests of the animal, and no additional harm is caused by the surgery, then such use is acceptable. It would not be acceptable to perform the same procedure on a terminally ill dog if it causes him/her additional harm, nor on a healthy shelter dog.

10. Policy on other use of live animals, animal cadavers and tissue for making alternatives

Under non-ideal circumstances the ethical production of alternatives may occasionally prove difficult. This section describes how the non-ideal use of and non-ideal sources of live animals, animal cadavers and tissue for making alternatives may under certain conditions provide an appropriate solution to this ethical challenge.

Deriving live animals for use in invasive and/or terminal procedures and animal cadavers and tissue from other sources, such as research facilities, slaughterhouses or farms, is therefore an acceptable compromise for the purpose of making an alternative when all 13 conditions in this section are met. The first three state:

10.1 An alternative for the practical does not already exist or is not practicably available.

10.2 The animal is genuinely required for making the alternative and no ethical source of a live animal or animal cadaver or tissue is available.

10.3 The alternative to be made will replace harmful animal use in education, and will be widely available for students to use.

Other conditions in this section state:

10.5 If live animal use is required, priority is given to the sourcing and use of an animal when he/she is suffering from natural terminal disease or serious non-recoverable injury and for whom a decision to euthanise has already been made by a qualified veterinarian with consent of the animal's guardian (if any), based on the interests of the animal and not motivated by practical or financial interests.

10.6 If an animal could be recovered and rehomed, then he/she should be recovered and rehomed and not used for a terminal procedure or one that will necessitate euthanasia.

10.7 All sourcing of a live animal and invasive non-terminal live animal use should result in some direct or indirect benefit for the animal, such as being saved from euthanasia, being neutered during a procedure, and being recovered and rehomed.

10.8 All invasive live animal use should cause zero additional harm to the animal and should not jeopardise the animal's future well-being except in certain circumstances during procedures involving an animal that is suffering from natural terminal disease or serious non-recoverable injury.

10.9 Harm caused during an invasive and/or terminal procedure on an animal is acceptable only when the harm is not subjectively experienced by the animal; and when it comprises the act of humane euthanasia.

Two examples illustrate the Policy. In both examples, it is assumed that no suitable alternatives already exist, that the planned alternative will bring about replacement, and that no ethical source of a live animal is available.

First, filming a surgical procedure performed on a terminally ill pig that is facing euthanasia at a farm: If the decision to euthanise was made by a qualified veterinarian, based on the interests of the animal and no additional harm is caused by the surgery, then such use is acceptable.

Second, filming a surgical procedure on a healthy pig at a farm: Although the procedure is not necessary for the individual pig, if no additional harm is caused by the surgery, then such use is acceptable if the pig is then saved from slaughter and rehomed. Such use is not acceptable if the pig is given to slaughter afterwards.

Summary

The InterNICHE Policy on the Use of Animals and Alternatives in Education presents comprehensive guidelines to support ethical and effective acquisition of knowledge and skills. Its strict nature reflects a strong commitment to the quality of life science education and makes clear the opportunities associated with alternatives and the freedom available to teachers to apply modern technology and progressive ethical thought to the learning process. The Policy helps shift the focus of the discussion from animal experimentation to that of best practice education and the tools and approaches to implement best practice. Integrating the Policy into regulations and legislation will further support modernisation of life science education.

Viewing the Policy

The Policy was first published in the book *From Guinea Pig to Computer Mouse: Alternative Methods for a Progressive, Humane Education* (Jukes and Chiuia, 2003). The Policy is an evolving document and the latest version is published on the InterNICHE website www.interniche.org. Comments from readers are welcome.

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Internationalising Alternatives in Higher Education

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Summary
InterNICHE has been working internationally to promote and implement alternatives in higher education for 17 years, facilitating the replacement of harmful animal use and building a broad network with contacts in over 50 countries. From the InterNICHE experience, successful international work requires qualities and practices from organisations that include: a bold and positive vision, a specific focus and an awareness of the links between issues; a commitment to pro-actively catalyse sustainable change and create win-win solutions; the design of organisational structures conducive to participatory democracy, alliance building and the organic growth of the network; the practice of solidarity and support for local initiatives rather than empire building; and the provision of resources and training for action and capacity building. The presentation will draw on examples of InterNICHE projects such as the production and multi-language translations of printed, video, and website resources; the Alternatives Loan System for trial of software, mannekins and simulators anywhere in the world; the international Humane Education Award for local development and implementation of alternatives, including freeware; support for student conscientious objectors; and conferences, outreach visits, and training in alternatives for teachers. The challenges met within such work will also be explored, and suggestions of how to overcome them will be given.

Keywords: alternatives, animals, education, freeware, grant, internet, InterNICHE, library, students, training, translation

Introduction

The International Network for Humane Education (InterNICHE) was founded in 1988 by student conscientious objectors, animal welfare scientists and anti-vivisectionists from Western Europe. It has since expanded to become a global 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. The growth of this unique network has been achieved through much voluntary commitment and with minimal financial resources. This paper explores the qualities and practices possible from organisations that can facilitate successful international work, using examples of InterNICHE philosophy, activity and organisational structure. It also addresses the challenges met within such work, and gives suggestions of how to overcome them.

Philosophy and vision

InterNICHE pro-actively catalyses progressive and sustainable change in life science education. The philosophy illustrated below informs this campaigning action. Philosophical consideration helps explore the ethics of an issue in depth, and ensures relevance and consistency of argument in an evolving field. It also informs organisational structure, decision-making and collaborative action, as well as the choice and design of projects and resources.

The InterNICHE vision is one of a fully humane education, brought about through full replacement of harmful animal use and the implementation of progressive learning tools and approaches. This bold and positive vision reflects the commitment and confidence of the international network of volunteers and collaborators. It is supported by the growing evidence of replacement that has already been achieved at universities across the world. The InterNICHE *Policy on the Use of Animals and Alternatives in Education* (Jukes and Chiuia, 2003) details in 10 sections the practical expression of this philosophy and vision. It provides comprehensive guidelines to inform curricular design, regulations and legislation.

Clarity of vision requires knowing the perspectives from the diversity of countries and world cultures. Awareness of difference as well as the shared value base and commonality of experience has supported the vibrant organic growth of the international network and of the broader humane education movement. A commitment to consensus decision-making and participatory democracy has further supported this.

InterNICHE campaigners keep a specific focus on alternatives in education whilst staying aware of the broader impact of curricular transformation in the scientific, ethical, pedagogical, social, and economic spheres. Working with this holistic awareness creates more opportunities for alliances to be found, avoids shifting problems from one sphere to another with an illusion of success, and allows for genuine progressive change with multiple positive impacts to be achieved. InterNICHE believes that win-win solutions to the ethical conflict surrounding harmful animal use are almost always possible, with replacement benefiting students, teachers, animals and the life sciences in general.

InterNICHE also has a strong commitment to critical thinking and ethical literacy, both of which are crucially important to education and true scientific endeavour. Critical thinking is the abil-

ity to question assumptions and ask for evidence, for example of the claimed but elusive advantages of harmful animal use over alternatives. Such a commitment also includes finding creative solutions to genuine challenges – such as exploring the practicalities of securing ethically-sourced animal cadavers as an alternative, so that even hands-on dissection can be achieved in a fully ethical way.

Creating sustainable change

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, solidarity and support for local initiatives, and provision of resources and other practical support.

InterNICHE campaigners work with teachers, students and other stakeholders. In some cases consensus can be reached easily and change implemented rapidly. InterNICHE provides one of the few forums where both abolitionists and animal experimenters can meet to discuss and search for common ground upon which to build some progressive change involving replacement. The existence of such a medium for communication is rooted in respect for people, inclusivity and empowerment: a recognition that everyone can be an agent for progressive change.

When such a co-operative process has been precluded by teachers, however, campaigning may involve actively challenging harmful animal use and the denial of student choice, peacefully and responsibly. Even during this, however, the overall aim is still on the positive: addressing best practice teaching through the most effective and ethical ways of gaining knowledge and skills.

The provision of resources to create more opportunities for achieving win-win solutions and to support people to make changes themselves are crucial aspects of achieving sustainable change. The InterNICHE Alternatives Loan System, offering alternatives for free loan to all countries, has given teachers opportunities to try out and become familiar with the diversity and quality of a range of existing products. "Hands-on" experience of alternatives and opportunities to trial products in advance of purchase are often essential steps leading to effective implementation. Other support includes the provision of training within countries, with alternatives that are relevant to the local curricula; a Humane Education Award, co-judged by National Contacts, that has supported the purchase, development and implementation of alternatives; and multi-language translations of information material, including the InterNICHE book, video and website described below. Many other smaller local initiatives are also supported.

Working with National Contacts and collaborators to support their own initiatives leads to change coming from within rather than being imposed from outside, and the change is therefore more likely to be fully relevant as well as sustainable. It is also likely to be more effective, as it is rooted in and responsive to local situations and values, and draws on existing local skills, knowledge and experience rather than ignoring them. With this approach of solidarity and partnership rather than empire building, InterNICHE can facilitate decentralised activity across the world.

Provision of resources and practical support

Some of the resources and practical support made available to facilitate sustainable change are described below.

Information

Information resources are necessary for teachers and others to make informed choices regarding curricular change and the right combinations of alternatives for the location. Gathering information on animal use and the ongoing replacement at universities is one task, and National Contacts may be active doing this. Provision of information is another task, and the network researches, provides and distributes such information internationally.

The InterNICHE book *from Guinea Pig to Computer Mouse* (Jukes and Chiuia, 2003) 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 is now available on-line, with plans for 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/animal care and use 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 Loan System, with links to producers. Free to download is the 33-minute InterNICHE film *Alternatives in Education* (1999) which features interviews and demonstrations of alternatives by teachers, and the sound files from the 2nd InterNICHE Conference held in Oslo (2005). The site has an increasing number of visitors, and was approaching 1.5 million hits and nearly 100 GB of download for 2005. Translations of the site into new languages now include Portuguese, Polish, Russian and Arabic, amongst others, providing the first on-line alternatives texts in some languages. The site is currently being redesigned to comprise many new facilities, in particular a large degree of interactivity and accessibility, and more on-line resources. Regional variations of selected content will honour the cultural diversity relevant to the issue and within the network, providing an appropriate degree of localisation.

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, step-by-step, along with testimonies from student conscientious objectors, are provided at the InterNICHE website. The shared experiences of other students who have been through similar situations, and the community of objectors and campaigners that InterNICHE has helped build can give power to those objecting and sustain them through the process towards success.

Some National Contacts are or have been conscientious objectors at the forefront of pushing for curricular change; in some cases they are the first in their country to graduate using alternatives only. 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 explore 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.

Alternatives Loan System

InterNICHE built a large library of alternatives during 2001/2002 to support practically the process of replacement worldwide. This evolving 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.

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 facilitate ease of borrowing by avoiding 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.

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, Czech Republic, Norway, 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. 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 Loan System are typically used, and training may involve collaboration with producers. In August-September 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 such a large number of delegates.

The Multimedia Exhibition at this 5th World Congress was also organised by InterNICHE, with National Contacts and collaborators as trainers. Future training is planned for other conferences and for outreach tours in Latin America, North Africa and the Middle East.

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 widespread 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 implemen-

tation of alternatives. Supported by 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 National Contacts. A translation into Russian is also under production: free alternatives developed in Eastern Europe have great potential across the former Soviet Union due a strong similarity between courses in the region, and the financial difficulties facing universities. 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, the purchase of a range of Indian-made anatomy models for donation to an Indian university, with cow models distributed to many veterinary colleges across the country. This has contributed towards replacement of killed buffalo calves and of the painful embalming methods used.

The challenges

With some of the international co-ordination being done in the West – the root of much historical and contemporary empire building – it is important for the organisation to be mindful of potential cultural insensitivity in its practice. As well as the solidarity and partnership approach described earlier, the semi-autonomous National Contacts are responsible for much of the activity in their country and can ensure that the approach taken there is appropriate and effective. The Committee of National Contacts and the rotating Core Group are also spread right across the world, bringing diverse perspectives to planning and decision-making. The multicultural and internationalist experience of those involved also plays a role: some have travelled extensively and have a history of solidarity and partnership work. As part of the commitment to full inclusivity and equal opportunities, the challenges facing National Contacts and other campaigners from "developing" and other soft currency countries, particularly those relating to funding, access to visas for travel, and access to alternatives, always inform the decisions made and projects undertaken. This is also true for the broader international network that involves teachers, students and producers.

Occasionally campaigners may hold assumptions about or not appreciate the challenges faced by colleagues living in very different circumstances, but often this is simply a matter of exposure. The network itself creates opportunities to develop an internationalist awareness that appreciates common experience and purpose on the one hand, and diversity and difference on the other. The 2nd InterNICHE Conference had representatives from 32 countries, and internal meetings are equally multicultural. Sharing of experience and skills is an integral part of InterNICHE practice, both informally and with the specific purpose of empowerment, for example through training and the execution of projects. Similarly, the InterNICHE culture of consensus decision-making, wherever possible and appropriate, may be unfamiliar where an individual's personal preferences are more hierarchical or where they previously experienced little decision-making power.

There is always an element of transient involvement in the movement from students, which some may see as problematic. If InterNICHE has provided inspiration and resources to support students to question the orthodoxy, conscientiously object and strive to implement alternatives during their education, then the transience is of no matter. Indeed, some individuals may contribute after graduation, for example as professionals pushing for alternatives, informed by their own positive or negative experience in education. Difficulties caused by changes in active contacts are minimised by having available to the public a range of information and other resources, and by a commitment to empowerment and training, so that stability and continuity is maintained through open access and best use of resources and skills. Nevertheless, continuity can bring great benefits, and is essential in some organisational roles.

Structure and process evolve over time, and need constant review to ensure that they maximise the opportunities for participation and empowerment, and minimise those for bureaucracy. The Co-ordinator and Core Group perform much of the day-to-day international work, with autonomy for decision-making where appropriate; they are answerable to the Committee. Much general decision-making in InterNICHE is made by National Contacts at committee meetings and conferences, organised when finances allow. With a Committee based in nearly 40 countries, meetings can be a challenge both practically and financially. E-mail lists and chat are used at other times, and virtual meetings are being explored as a logistical solution to meeting in person. Networking opportunities at other events are used to the full, and regional meetings are also planned.

The rapid growth of the organisation, network and indeed movement for humane education has brought other challenges. More funds are needed, and though positive by being rooted in success, the challenge of work overload in the organisation can be difficult. The allocation of new roles within the organisation is one approach used to solve it. These include establishing new international roles, including regional co-ordinators, and encouraging National Contacts to build local groups. The role of named collaborators, including individuals or specific university departments, is being established to bring new people into the network and create non-executive roles with co-responsibility for specific projects. The establishment of the micro-Loan

Systems of alternatives is another aspect of ongoing decentralisation of resources that accommodates the growth and meets the needs of the network. And the restructuring of the InterNICHE website for more interactivity and automation allows for easier translation into new languages and for active participation by a broader network of individuals as the movement globalises further.

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