Introduction

The use of animals in higher education has positive and negative implications for students and teachers. Studying real animals or animal tissues offers an interesting learning experience. It gives students the opportunity to learn about species that are not commonly kept in your laboratory by observing them in their natural habitat. Therefore, if students are not being taught about the diversity of wildlife in the laboratory, they will not get a chance to appreciate the diversity of the different species in their natural habitat. Additionally, students who are trained to perceive the diversity of wildlife in the laboratory will not be able to appreciate the benefits that these species can provide to humans.

Pedagogical impact of harmful animal use in higher education

Although only about 3-5% of students actually speak out, many (sometimes up to 67%) of students are concerned about the suffering and sacrificing animals for educational purposes. However, students perceive a need to act to protect ‘animal welfare’. Some ‘sensitive’ individuals do not enrol or drop out of life science courses when encountering harmful animal use. Once convinced, they are less likely to peer pressure from educators to conform. Harmful animal use may lead to empathetic distress, which may inhibit learning processes. Furthermore, prolonged involvement in harmful animal use may lead to desensitization (Capaldo 2004).

The role of educators

Educators are authorities which serve as role models. In reality they often teach the way they were taught and they may be resistant to change. Ethical and animal welfare issues receive cursory, if any, discussion in most animal experimentation classes, indicating that ethics do not matter as much as the scientific subject under study. Innovation in higher education may be delayed if educators are too reliant upon traditional methods involving harmful animal use.

Introducing alternative models in higher education

Many factors influence the adoption of alternative models in higher education, including:

1. Student pressure leading to choice policies or to replacement of certain animal use altogether, such as terminal surgery laboratory classes in veterinary education
2. Faculty decisions related to financial pressure or lack of skilled personnel or equipment to assist with classes involving real animals
3. Teachers choosing for innovative IT-enhanced education resources
4. Teachers choosing alternative models which generate equivalent or better didactic results

Despite many available alternative learning resources, the number of animals used in education is about 20% of the total number of animals in experimentation in most countries. This figure is either stable or is slightly rising. One of the obstacles to introducing alternative methods is that teachers are not aware of the latest developments in the field of alternatives (Lohe pers. comm. 2004).

In order to aid teachers in their search for information about alternatives and to find out whether non-invasive techniques are appropriate in replacing the animal model, I developed a review form to assess the suitability of alternative resources, while working at the European Resource Centre for Alternatives in higher education (EURCA, www.eurca.org). Lecturers from different disciplines (physiology, anatomy, pharmacology, etc.) were invited to submit reviews to EURCA.

The 6 main topics examined in the EURCA review form are:
1. Didactic comparison of the alternative resource with real animals in the laboratory
2. User-friendliness of the resource
3. Contribution of the resource to awareness of 3Rs (Replacement, Reduction and Refinement)
4. Applicability to teaching situation/curriculum
5. Visual appearance
6. Level of service provided by the supplier

Table 1. 20 reviews from the EURCA database

<table>
<thead>
<tr>
<th>No.</th>
<th>Title of alternative model</th>
<th>Type</th>
</tr>
</thead>
<tbody>
<tr>
<td>1</td>
<td>Anaesthesia of Rat</td>
<td>CD-ROM</td>
</tr>
<tr>
<td>2</td>
<td>Cardiac Respiration</td>
<td>CD-ROM</td>
</tr>
<tr>
<td>3</td>
<td>Cell Physiology</td>
<td>CD-ROM</td>
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<tr>
<td>4</td>
<td>Mucosal Physiology</td>
<td>CD-ROM</td>
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<tr>
<td>5</td>
<td>Microscopy</td>
<td>CD-ROM</td>
</tr>
<tr>
<td>6</td>
<td>Mouse Weight</td>
<td>CD-ROM</td>
</tr>
<tr>
<td>7</td>
<td>PVD Rat</td>
<td>Mannequin</td>
</tr>
<tr>
<td>8</td>
<td>SimBart</td>
<td>CD-ROM</td>
</tr>
<tr>
<td>9</td>
<td>SimHound</td>
<td>CD-ROM</td>
</tr>
<tr>
<td>10</td>
<td>SimMed</td>
<td>CD-ROM</td>
</tr>
<tr>
<td>11</td>
<td>Pharmacology Simulation Jaju</td>
<td>CD-ROM</td>
</tr>
<tr>
<td>12</td>
<td>Pharmacology Simulation Jaju</td>
<td>CD-ROM</td>
</tr>
<tr>
<td>13</td>
<td>Simly – The Virtual Rat</td>
<td>CD-ROM</td>
</tr>
<tr>
<td>14</td>
<td>The Rat – A Functional Anatomy</td>
<td>CD-ROM</td>
</tr>
<tr>
<td>15</td>
<td>Virtual Dissection, Hook</td>
<td>CD-ROM</td>
</tr>
<tr>
<td>16</td>
<td>SimKnee – The Complete Knee</td>
<td>CD-ROM</td>
</tr>
<tr>
<td>17</td>
<td>Critical Care, Jerry</td>
<td>Mannequin</td>
</tr>
<tr>
<td>18</td>
<td>Comparative Anatomy</td>
<td>CD-ROM</td>
</tr>
<tr>
<td>19</td>
<td>Virtual Anesthesia Machine</td>
<td>Website</td>
</tr>
<tr>
<td>20</td>
<td>Virtual Anesthesia Machine</td>
<td>Website</td>
</tr>
</tbody>
</table>

Methods

20 reviews (Table 1) of alternative models by 16 different reviewers were analysed. Results differed in nature and many comments only pertain to a particular model, however, some commonalities are summarised below for each main topic of the review.

1. Comparison to real animal lab
   - Students are less confronted with negative emotions when gaining confidence more rapidly, and knowledge acquisition is facilitated by reduced stress levels (1, 7, 15, 17).
   - They are better prepared for conducting procedures on real animals later on, which contributes to ‘Reference’ (1, 6, 17, 16).
   - Alternative models often promote gathering and reinforcing factual and theoretical knowledge (most models).
   - To some extent they are suitable for data recording, analysis and interpretation.
   - Many (electronic) alternative models are less suited for learning experimental design or for the acquisition of laboratory skills, although mannequins are suitable for the latter objective.
   - Alternative models contribute to achieving goals that would be hard to reach via traditional animal labs: eg manipulation of variables (7, 9, 13, 20).
   - The objectives of some models have the potential to be achieved in a superior way than if real animals were used (1, 2, 9, 13, 17).
   - Most models are more suitable for introductory learning at undergraduate level and less suited to achieve advanced learning objectives or to develop complex skills (5, 9, 13).
   - Some reviewers regard the model as a refinement or reduction alternative, as they still view live animals as being essential in education (4, 6, 7, 14, 15, 16, 18, 20).

2. Using the resource
   - Navigation of Computer Aided Learning (CAL) resources is easy in most programs and most models run well. One reviewer (15) suggested running the program in HTML would improve it.
   - Most models are user-friendly; instruments and tests are easily adjusted and performed by a simple mouse-click.
   - Some techniques used do not always resemble the real situation (6, 9, 11, 12, 16). Descriptions of the techniques may also be missing (1, 2, 3).
   - Video material within a few programs is much appreciated (19).

3. Contribution of the resource to awareness of 3Rs
   - There is no implicit reference to the importance of the 3Rs in most models, which may cause students to be unaware of the implications of animal experimentation.
   - Many models make students aware that CAL can be as good as or better than animal labs.
   - One model (9) discusses the animal in its natural environment, which may stimulate discussion about ethics and/or learning about ecology.

4. Applicability to teaching situation/curriculum
   - Most models are interactive learning tools, some of which are simulations of real experiments, either using stochastic data or fixed values.
   - Contents are generally correct and do not display major mistakes, but sometimes important content or summaries are lacking (1, 2, 3, 5, 6).
   - When an introduction and/or discussion is missing, teacher input becomes necessary before and after the session (6).
   - Figures, images and schematic overviews would improve the link between the methodology and experimental results (2, 4).

5. Visual appearance / Level of supplier support
   - Many models can be used without prior knowledge, although for some models basic knowledge is a prerequisite (2, 3, 5, 7, 20).
   - Many models can be used in self-directed learning settings but in some programs students would need guidance from tutors to go through the activities (4, 5, 7, 8, 10, 14).
   - Some reviewers mention reduced staff time as an advantage of the models.
   - Some models promote group work or discussions (4, 7, 16) which enhances learning.
   - The experimental set-up is often schematized with very restricted possibilities for parameter changes or conditions, which is not conducive for learning in an explorative way (3, 5, 6, 8).
   - Programs allow for declaring-making (13), but are primarily demonstrations. The level of interaction could be improved (3, 6, 8).
   - Self-tests, if included, are very useful in repeating the core messages. However, correct answers to a quiz do not guarantee that students successfully understand and perform experiments.

6. Program set-up and explanation of experimental design
   - Students are better prepared for conducting procedures on real animals later on, which contributes to ‘Reference’ (1, 6, 17, 16).
   - Alternative models often promote gathering and reinforcing factual and theoretical knowledge (most models).

Discussion

The reviews are generally positive, although there is room for improvement, eg:

- Program set-up and explanation of experimental design
- Level of interaction and possibilities to change parameters
- Using more realistic data/representations of animals
- Including video clips
- Offering programs in web-based formats
- Including opportunities for developing manual skills
- Data recording, interpretation and presentation of data

Reviewers often regarded the models they assessed as reduction or refinement alternatives. If we are to move towards further replacement of harmful animal use, essential improvements need to be made in existing models and key didactic factors need to be taken into account when designing new alternative models.

The University of Wollongong (Australia) Conscientious Objective Policy provides a helpful example: "Where alternatives to teaching or assessment activity are provided by an academic unit, they should have similar pedagogic goals, be of comparable difficulty, and should require similar amount of time and effort, and be assessed as rigorously as the activity which they replace."

Attitudes and performance

Most students have a positive attitude towards CAL (Devhurst et al 1994), although feedback, internal and discussion should be an integral part of programs. Systematic comparative reviews reveal equivalent or superior learning achievements when using alternatives (www.bristol.ac.uk/biosciences/courses.html). Some reviewers were more critical of the models they reviewed. However this does not automatically mean that student performance would be worse than that achieved through harmful animal use. After all, an educational tool can be state-of-the-art, but if teacher input is minimal or even negative, students are likely to fail.

It is my hope that these reviews help lecturers select the most educationally sound method that includes a comparative view towards animals and that such ‘alternatives’ become mainstream in higher education.

References

For a similar (oral) presentation of this topic, please visit: www.interchiro.org/2005Conference/online.html and click on “Teachers’ assessment of alternative educational models” for a free sound recording

Dewhurst ATLA 1994 The psychological effect of students of using animals in ways that they see as ethically, morally or religiously wrong. ATLA Supplement 1: 55-58
