

The animal experimentation controversy: ethical views of prospective teachers

RIAN DE VILLIERS

University of Pretoria

Vivisection (live animal experimentation) is a controversial issue for many people. The purpose of this case study is to examine the attitudes of prospective teachers toward vivisection in education and research, to determine if gender has an influence on these attitudes, and to discuss the implications of these attitudes with regard to teaching of the disciplines in the life sciences. A sample of 100 prospective life sciences and natural sciences teachers from a South African university responded to a questionnaire on vivisection in education and scientific research. The responses were analysed qualitatively and quantitatively. The results showed that most prospective teachers are in favour of animal rights and that females are more averse to vivisection than males. A number of suggestions are made with regard to vivisection in schools and tertiary institutions.

Keywords: vivisection, animal experimentation, education, research, teachers, students, learners, ethics

Introduction

Every year millions of animals are used as objects for experiments in education and many are harmed or killed for this reason. The Animal Studies Group (2006) argues that almost all areas of human life are at some point or other involved in the killing of animals (Pedersen, 2010). Currently, most people are concerned about the protection of our natural world and have a great respect for animals. At the same time, however, our rapidly growing knowledge of science and technology presents us with increasingly complicated moral issues. Horsthemke (2010) points out that animals and humans have equal moral subject status. Animals, and especially mammals, are currently seen as convenient objects for education and research simply because we are prejudiced in favour of our own species – *Homo sapiens*.

There are few areas as controversial and emotional as that of the use of animals in education and scientific research. An animal can be defined as a living organism that feeds on organic matter, typically having specialised sense organs and a nervous system, able to respond rapidly to stimuli and can move voluntarily. The use of animals in education and research can be considered from two aspects: “whether it is ethical to use animals, and whether animals are used ethically” (Mitchell, 1990: 69). The debate on values is likely to create considerable controversy in life sciences, natural sciences, veterinary sciences, zoology, physiology and anatomy classrooms where topics like animal dissection and vivisection unite to challenge the deepest emotions of academics, learners¹, students² and the public.

What is vivisection? The word ‘vivisection’ was originally used to describe the cutting up of live animals in scientific experiments. Today, the term is used more to describe any experiment that causes pain, distress or harm to a living animal. Vivisection involves animals that are poisoned, starved, blinded, deprived of water, subjected to electric shocks, subjected to invasive surgery and infected with dangerous diseases. In some cases, animals are subjected to more than one experiment (*Animal experiments*, 2000). The list of mammalian animals used is almost endless: from rabbits, guinea pigs and farm animals, to monkeys and ‘companion animals’ such as cats and dogs.

In schools in South Africa, revised national curricula in the natural sciences and life sciences (previously known as biology) have been introduced (Department of Education 2002, 2003) and implemented. A re-writing of the curriculum has meant that many of the old assumptions about what should be taught, to whom, at what stage, and how, have been under sharper scrutiny than in other countries where change has been less radical (De Villiers & Monk, 2005). A requirement is that learners, as responsible

citizens, need to evaluate the past and make informed decisions about the present and future use of science and technology in society. The *National Curriculum Statement: Life Sciences* (Department of Education, 2003) raises learners' and students' awareness of the existence of different viewpoints in a multicultural society, and encourages open-mindedness towards perspectives that are based on scientific knowledge, beliefs, ethics, attitudes, values and biases. However, the consequences of these requirements for training teachers are a major concern. From my own experience, most teachers are unfamiliar with the approaches needed to develop the necessary skills of argumentation and debate in their learners.

Despite the fact that the attitudes of people with regard to the use of animals could form barriers to effective learning (De Villiers & Sommerville, 2005), little is known about prospective South African life sciences and natural sciences teachers' opinions in this area. Vivisection is a mandatory component of the Grade 12 life sciences curriculum (the final year of secondary schooling) under the theme 'Animal responses to the environment'. Some examples of these sections include: observation of the response of some invertebrates to light and humidity; observing and relating the sensory organs of groups of animals in relation to the mode of life; observation of papillary mechanism; and investigating behavioural, physical and/or physiological adaptations for thermoregulation in animals.

Some people may feel that animal research is simply wrong, regardless of the crucial role it plays in medical progress, while others may feel that its morality depends on the objectives and achievements. It may also depend on whether it is carried out humanely and what the consequences might be if it were not carried out at all (Hobsons Academic Relations, 2001). This is an issue on which there are many conflicting views, and the opinion of any one individual may change with additional information and experience within a few days. On the one hand, the anti-vivisectionists are asking for educators and educational institutions to recognise that animals are sentient beings and that we have a duty to represent them as something other than disposable instructional objects. On the other, it makes sense for vivisectionists to have first-hand experience of what one is teaching and, as in the case of veterinarians and physicians, vivisections could be classified as vocationally necessary for life sciences and natural sciences teachers.

Taking the wider view, medical and scientific research have made the lives of many people better than their lives would otherwise have been. Nonetheless, medical, scientific, and technological breakthroughs bring with them even more difficult questions: Should researchers and educators employ data obtained from inhumane experiments on animals? Is it morally justifiable to take the lives of healthy animals in the name of education and research? Should we draft one set of moral guidelines for primates and another for the lower orders? Should dissection and vivisection be classified as vocationally necessary for life sciences and natural sciences teachers? The answers any society finds to such questions, at any stage, are located within wider political and socio-economic frameworks.

Globally in universities, colleges and schools, the debate about the role of vivisection in education continues, especially in regard to mammals. Different practices are possible, and these practices evolve as wider debates about differences and similarities, rights and responsibilities seep into the academic realm, classrooms and laboratories. What is considered acceptable in the laboratory is an indicator of the state of such debates in the wider society (De Villiers & Monk, 2005). South Africa is not the first to raise questions about animal use in education and research. In some countries, particularly in the United States (see Capaldo, 2004; Orlans, 1991; Vollum, Buffington-Vollum & Longmire, 2004) and Europe (see Foster, Stannistreet and Boyes 1994, Guerrini 2003, Smith & Smith 2004, Stannistreet, Spofforth & Williams 1993), some controversial questions regarding vivisection have long been debated. Smith and Smith (2004) found that the exposure of students to animals (whether alive or dead) is a dramatic event for most of them, and the effect it has will depend heavily on their previous experience with that species, their moral values and the perceived necessity of the practical application. A study conducted by Stannistreet, Spofforth and Williams (1993) revealed that 87% of secondary school learners believed vivisection to be wrong. According to Foster, Stannistreet and Boyes (1994), nearly three quarters of the learners found vivisection for educational purposes unacceptable. Guerrini (2003) argues that it is not for scientists alone, but for all of us to determine the values of our society. However, in developing countries such as those in Southern Africa, the debate on vivisection in education and research is new to the public

domain. The study of De Villiers and Sommerville (2005) revealed that 70% of the South African life sciences students had positive attitudes in regard to animal dissection. However, this study was limited to prospective teachers' attitudes to dissection only. It identified a need for a survey of wider ethical views of prospective teachers.

Research questions

The following are the research questions that guided the data collection and research methods:

- What are the attitudes of prospective life sciences and natural sciences teachers towards vivisection and using animals in scientific research?
- Does gender influence these attitudes?
- What are the implications of the prospective teachers' attitudes in regard to the teaching of life sciences and related subjects?

Research methodology

Lecturer, sample and participants: The researcher in this study is a lecturer teaching zoology for prospective life sciences teachers. A quantitative research method was used to generate data to address the research questions above. To select participants for this research, purposive sampling was utilised. A sample of 100 Bachelor of Education (BEd), prospective life sciences and natural sciences teachers at a single, urban university in South Africa, participated in this empirical study. Only prospective teachers enrolled for the courses in zoology or the learning area science (it was compulsory for all prospective teachers who passed zoology in the third year to enrol for this module) were involved in the preliminary study.

Instrument: Information was collected by means of a questionnaire, which prospective teachers completed voluntarily during routine classes. The questionnaire was approved by the Faculty Research Ethical Committee. The research met the ethical guidelines laid down by our university for educational research, including voluntary participation, informed consent, confidentiality, anonymity, trust and safety in participation. The instrument contained both open-ended and closed questions, which elicited responses in regard to individual beliefs, experiences and actions. The responses yielded demographic data as well as information on prospective teachers' personal experiences of and attitudes towards vivisection and animal rights. The demographic items had bearing on age, year of study, gender, religion and cultural group. The attitudinal items on the questionnaire consisted of 29 statements in total, divided into sections that dealt with vivisection (16 statements) and using animals in scientific research (13 statements). Most of these statements were obtained from *Wasted Lives* (Animal Aid Education Department, 2001). In each case the prospective teachers were required to tick one of five options on a Likert scale to indicate to what extent they agreed or disagreed with each statement: (1 = strongly agree, 2 = agree, 3 = uncertain, 4 = disagree, 5 = strongly disagree). Ten open-ended questions were included in the questionnaire.

Data analysis procedure: The responses to the open-ended questions were analysed qualitatively. Emerging patterns and themes were used to code the qualitative data. The responses to the closed questions were analysed only quantitatively. Statistical analysis (summary statistics and two-way tables) of the survey data was used to elaborate and enhance the discussion. The Likert responses were reduced to two: agree ('strongly agree' and 'agree' combined) and disagree ('strongly disagree' and 'disagree' combined). Negatively worded statements were 'reversed scored' to be aligned with the 'positive' statements. The responses to all the statements in the sections were tested for association with demographic characteristics of the respondents. Religion could not be tested because the majority (93%) of the respondents were Christian. The Chi-squared test was used to test for association with Gender. Fisher's Exact test was used to test for association with culture because the 2-way contingency tables were sparse with some expected frequencies less than 5, which makes the Chi-squared test inappropriate. Results are presented as percentages rounded to whole numbers. Cronbach's alpha coefficient test was used to measure reliability. Only those statements with statistically significant associations (see Table 1) will be discussed.

Validity and reliability: The questionnaire's content validity was face-validated by three experts in the field of life sciences, who are competent to judge whether the questionnaire reflects the content domain of the study. The questionnaire was pilot-tested with 15 students enrolled in the third year of the zoology course. Based on the feedback of the pilot study and from the experts, the questionnaire was revised. Ambiguities and redundancies were removed to improve the clarity in the formulation of items in the questionnaire. The reliability of the questionnaire was tested using Cronbach's alpha coefficient (Cohen, Manion & Morrison, 2007).

Findings

Biographical information

One hundred (91%) out of 110 questionnaires were returned. The ages of the respondents ranged mostly between 20 and 22 years. Thirty-six per cent were first year students, 12% second-year students, 16% third-year students and 36% fourth-year students. All these students were prospective teachers and the majority of students (74%) were female. Regarding religious background, 5% had no religious background, 93% were Christian and 1% Hindu. One student indicated his religion as "other". The sample represented diverse South African culture groups: Afrikaans (33%), Tswana (15%), Northern Sotho (12%), English (12%), Zulu (9%), Swazi (9%), Ndebele (7%), Southern Sotho (3%), Xhosa (1%) and Indian (1%).

Demographic comparisons

Gender

The study revealed that there are decided differences in the responses of the genders. Males and females respond differently to vivisection and using animals in research. The Likert scale analysis of the results provided statistical evidence that male and female students respond differently to vivisection and animal rights statements. In general, male students gave less sympathetic responses than females. Nine questionnaire statements (Table 1) show a statistically significant association between gender and the students' response statements. All these statements were statistically significant at the 0.05 probability level. The responses from students were 0.90 (a high reliability) for the scientific research statements and 0.87 (a moderate reliability) for vivisection statements when testing gender associations using Cronbach's alpha coefficient. According to Pietersen & Maree (2008), reliability estimates of 0.80 are regarded as acceptable by researchers.

Table 1: Results of statistically significant associations between gender and responses to animal research and vivisection statements (statistical probability value, $p < 0.05$)

Statements	\bar{x}	<i>s</i>	P-values
<i>More males agree than females:</i>			
The use of monkeys in drug experiments to develop a vaccine against heroin addiction	3.56	1.40	0.0285
Genetically engineering sheep to produce medicines in their milk	3.06	1.48	0.0041
Experiments on cats to test the effectiveness and safety of a specific pill	3.58	1.35	0.0426
The use of dogs in heart disease research	3.48	1.31	0.0418

Statements	\bar{x}	s	P-values
Use of hamsters for research into malaria	3.11	1.41	0.0017
Cloning cattle	3.23	1.41	0.0050
Animal experimentation yields more benefits than abuses	3.27	1.08	0.0375
It is morally justifiable to take the lives of healthy animals for the sake of education	3.70	1.20	0.0324
<i>More females agree than males:</i>			
We don't have the moral right to conduct painful experiments on animals or make them suffer for our benefit	2.10	1.28	0.0153

P = probability value; \bar{x} = mean; s = standard deviation

The results revealed that more male than female students agreed with eight statements (Table 1) at a 0.05 statistically significant level. More than half (54%) the males were in favour of monkeys being used in drug experiments to develop a vaccine. This was unexpected because monkeys are high on the phylogenetic scale and are anatomically closely related to human beings. Sixty-five per cent of the female students were against this type of practice. More males (69%) than females (49%) were in favour of genetically engineering sheep in order to produce medicines in their milk. Less than half of the male students showed positive responses to the use of cats and dogs (46% and 38% respectively) in experiments. Fifty-six per cent of the females disagreed with these two statements. This affirms expectations because cats and dogs are common household pets. Many male students (35%) were uncertain about the use of dogs in heart disease research. Although hamsters can also be seen as pets, 60% of the males were in favour of the 'use of hamsters for research into malaria'. Forty-eight per cent of the females disagreed with this statement. The statement regarding the cloning of cattle elicited positive responses from only 56% of the males and 22% of the females. More males (39%) agreed that animal experimentation yields more benefits than abuses. A high percentage of females (45%) indicated that they were uncertain. Surprisingly, two-thirds of the female students thought it was not morally justifiable to take lives of healthy animals in the name of education. However, the responses of the males were more or less equally distributed: 31% agreed, 31% were uncertain and 38% disagreed. There are few differences between the standard deviation ranges ($s = 1.08-1.48$) of the nine statements (Table 1). The relatively low standard deviation suggests that students were quite consistent in relation to the vivisection statements. The mean scores ($\bar{x} = 3.06-3.70$) indicate that there are no statistically significant differences between statements grouped under 'more males agree than females'. More females than males agreed with only one statement (see Table 1), which had a statistical probability value less than 0.05. Just more than three-quarters (77%) of the females agreed that we, as human beings, don't have the right to conduct painful experiments on animals.

Experiences

Exposure to vivisection

Almost all the students (98%) have had exposure to experiments with live animals (Table 2). Some students indicated more than one exposure type. More than three-quarters (81%) of the respondents had watched a TV programme, video or film and had read or heard about live animal experiments. Only 9% indicated that they have had exposure to all four items mentioned in the table.

Table 2: Responses (%) of students' exposure to live animal experiments

Types of exposure	Male	Female	Total
Read or heard about	10	32	42
Watched a TV program, video, film	11	28	39
Watched your instructor	3	7	10
Done it yourself	2	6	8
None at all	0.5	0.5	1

Emotional reactions

Participants were asked to describe their emotional reactions when they first saw or participated in a live animal experiment. Their responses to the open-ended question were classified as positive (18%), mixed (21%), or negative (61%). Most of them had seen animal experiments with mammals through the media. More females (83%) than males (50%) responded negatively about vivisection. The following responses reflect some prospective teachers' views.

Typical *positive* responses provided by five prospective teachers were:

"I liked it very much, loved being directly involved. Did not feel disgusted, but we did it in an orderly way" (Female)

"The experiment was professionally done. I do not feel offended. I do not feel that the animal suffered" (Female)

"It was an exciting moment for me" (Female)

"It felt like I'm really getting in touch with science at first hand. It felt good" (Female)

"I was very amazed and I was happy to see such a thing in my life" (Male)

Some prospective teachers experienced *mixed* feelings towards vivisection:

"At first I didn't like it and after the description of the experiment and stating the results of the experiment, I felt it was of importance" (Male)

"It was painful to see animals treated that way but what make me feel better; it was for the human benefits" (Male)

"Interesting, enjoyable, can be quite emotional and sometimes sad!" (Female)

"I felt bad about it but I understand the reason behind it. According to me the act was justifiable and necessary for knowledge purpose" (Male)

"It depends on how the experiment was done. Some experiments were shocking and disturbing. But in some cases it was understood" (Female)

The following comments reflect some prospective teachers' *negative* reactions:

"It is the cruellest thing anybody can do. All animal experiments should be banned" (Female)

"It hurt me a lot, and I don't want to experience it again" (Female)

"I was angry and disgusted by the actions of the people who were doing those experiment. I actually cried and was very hurt. People like this give mankind a bad name" (Female)

"I was very scared and emotional because animals have a right as much as human beings. They are God's creation" (Female)

"It was sad an animal had to lose its life for the benefit of human beings. What gives us the right to justify it?" (Female)

Attitudes towards vivisection

One section of the questionnaire showed thirteen of the methods society used live animals for scientific research. In response to the question, ‘Do you think any of the experiments should be banned?’ the highest number of responses indicated that eye-irritancy tests on rabbits to test a new shampoo are morally wrong (52 responses), followed by the use of monkeys in drug experiments (41 responses), experiments on cats to test the effectiveness and safety of a specific pill (38 responses) and the use of dogs in heart disease research (36 responses). Interestingly, in all the above-mentioned tests mammals were involved. Only 14 responses were noted regarding experiments on chickens to develop new veterinary products for use on factory farms. In response to the question ‘Are you for or against animal rights?’ 90% indicated that they were for it. Not many more females (92%) than males (85%) were in favour of animal rights.

The students’ responses to the open-ended, follow-up question as to ‘Why are you for animal rights?’ were classified into six categories (Table 3). The main reason for prospective teachers’ positive responses involved the ‘treat with respect’ category. Responses included:

“We need to protect our animals” (Female); “they are able to feel pain” (Female); “they are God’s creatures” (Male); “they deserve to be treated the way humans are treated” (Female); “they should have the same rights as humans” (Female); “the abusing of animals is morally wrong” (Male); “it doesn’t mean if they can’t talk they don’t have feelings” (Male); “we depend on animals for food, clothes” (Female); “they will be extinct” (Female) and “they should be treated with respect” (Female).

Table 3: Positive responses (%) as to why prospective teachers were in favour of animal rights

Categories elicited from students’ comments in support of animal rights	Male	Female	Total
Treat with respect	6	15	21
Pain/feelings/emotions	2	17	19
Compare with human beings	2	15	17
Abuse/cruel/inhumane	2	8	10
Created by God	1	11	12
Conservation/extinction	2	6	8

More prospective teachers favour vivisection in research than in teaching. A large number (63%) of the respondents favour vivisection in research – more males (81%) than females (56%). Fewer prospective teachers (51%) favour vivisection in teaching – again, more males (80%) than females (41%). Positive responses included: *“it stimulates career opportunities”* (Male); *“understand learning content better”* (Female); and *“hands-on experience – learn more”* (Male). Just less than half (48%) the prospective teachers indicated that they consider it right to use live mammals to help find treatments for human illnesses. Once again, more males (58%) showed a positive response.

Some 69% of the prospective teachers disagree (responded either ‘disagree’ or ‘strongly disagree’) that it is morally wrong to do research on live animals if their physical appearance is considered, followed by the size (57%), rareness (52%), adaptability to the temperature of the environment (49%), intelligence (49%) and the position on the phylogenetic scale (39%). These findings support Pedersen’s (2010) results where the animal’s physical appearance and accessibility for cuddling seemed to be highly valued by many students. The present results showed that a large number of students (28%) were uncertain about the importance of animal positions on the phylogenetic scale. There was no remarkable difference between the mean evaluation scores of the six statements; they varied between 3.18 and 3.94 out of a possible 5.0.

Discussion and conclusion

Seeing that some of the demographic groups in this research were too small for statistical testing and to identify significant relationships (e.g. religion and culture), the focus fell on larger groups (e.g. gender). Despite these limitations, the information gleaned from the small number of participants in this study can be used to raise issues and possibly initiate some debate in terms of vivisection in education and research.

A new sensitivity is emerging about the appropriate use of living animals in education. This study showed that many prospective teachers of different cultures and gender have a deep respect for an animal's life and oppose vivisection in teaching. Educators (teachers and lecturers) have to instil in learners and students (i.e. prospective teachers) a respect towards nature. In addition, some religions (e.g. Buddhism and Hinduism) do not support the killing of animals. Students (i.e. prospective teachers) and learners should appreciate the fact that solutions to ethical problems are influenced by what is culturally acceptable. According to Conner (2010), an awareness of different cultural perspectives helps to develop appreciation and tolerance of other viewpoints.

The responses of prospective teachers to the attitude statements have important implications for those teaching any life sciences component of a science curriculum. Educators' attitudes towards animals can affect learners' and students' attitudes towards animals. The study by Pedersen (2010) showed that students easily adopt their teacher's point of view. Since educators are mediators between the general scientific view and the learners' and students' views of the world, their attitudes have important implications for the learners or students they teach. Educators need to understand their learners' or students' concerns and feelings about vivisection and should endeavour to meet their intellectual, emotional, and moral needs. Learners' and students' negative attitudes may impinge on the subject the educator is teaching and result in detracting from or resisting effective learning. An educator's opposition to vivisection could inhibit the intellectual needs of some learners and students. According to Van Rooy (1997), the main purposes of using animals in teaching are observing, selecting relevant observations, looking for patterns in observations, and seeking to explain these patterns by suggesting hypotheses. However, the question arises whether it is critically important to do these observations in the classroom or laboratory.

Although vivisection has lessened human suffering, saved human lives and advanced scientific understanding, the same research can cause distress and pain for the animals involved and may result in their deaths. It is hardly surprising that vivisection raises complex questions. Does a learner or student have a right to conscientiously object to practical sessions that involve harming or destroying animals? Does the educator have the academic freedom to provide a complete and accurate lesson/lecture to learners and students? Do animals have just as many rights as humans to be free of pain, abuse and exploitation? The decisions about the use of animals in scientific research and education are critical in making decisions in the broader context of ethical and social values.

Learners and students with scientific, religious, moral and ethical objections to vivisection have a right not to be discriminated against because of their compassion and respect for life. Educators may not exclude from a course learners and students who are strongly concerned about the rights of animals. They have to re-examine the morality and instructional effectiveness of this practice. Learners and students have the right to learn and animals have the right to live. Therefore educators may find it difficult to accommodate both principles in an acceptable manner.

The National Department of Education in South Africa has remained silent on animal experimentation in life sciences and natural sciences education and leaves the issue open. According to Hopkins (2008), animals have no rights under South African law. Mechanisms, and especially in schools in South Africa, should be put in place to ensure that all use of animals is in compliance with the principles of the *South African National Standard* (SANS) published in 2008. The purpose of this publication is to ensure the ethical and humane care of animals used for teaching activities as well as scientific purposes. Its clause, "The use of animals to demonstrate knowledge or techniques in scientific disciplines in schools and tertiary institutions" (SANS, 2008: 16), refers to three important general principles. Firstly, animals should be used for teaching activities only when there are no suitable alternatives for achieving the educational objectives. Secondly, students should be given the opportunity to discuss the social, ethical, and scientific issues

that are involved in the use of animals for teaching activities and scientific studies. Thirdly, all teaching activities which involve the use of animals must have the approval of an Animal Ethics Committee. This committee has to indicate that they are satisfied that there is no suitable alternative to the use of animals, and that the number of animals involved and the impact on them is minimised. (In South African schools, such Animal Ethics Committees do not exist). Where students are involved in the use of animals as part of their professional training, curricula in that academic discipline should include material on such issues.

Educators must be sensitive to students' and learners' needs, and should create an awareness of alternative instructional tools such as films, videos, models, and multimedia computer simulations. Despite numerous educational alternatives (Merikangas, 2011), vivisection is included in many courses, e.g. life sciences, natural sciences, anatomy, physiology and zoology courses. Given the alternatives in schools and tertiary institutions, prospective life sciences and natural sciences teachers and lecturers teaching these disciplines should receive training in these alternatives. As a result of objections to practices of vivisection in schools and tertiary institutions, groundbreaking work has been done by many volunteers and professionals to develop alternatives to these practices. One is the International Network for Humane Education (InterNICHE) whose main focus is on the replacement of animal use and the implementation of alternatives in education. Studies have shown that skills, knowledge and ethical awareness can be gained more effectively using progressive, alternative methods (Downie & Meadows, 1995; Greenfield *et al.*, 1995).

Another crucial issue is that we as educators do little to prepare our learners and students to overcome many scientific ethical obstacles they may encounter in their occupations. A bioethics component should be included in all anatomy, physiology, life sciences, natural sciences, veterinary sciences and zoology courses. There is still debate about the extent to which ethics should be taught within life sciences and related courses (Reiss, 2010). Ethics programmes should aim to heightening ethical sensitivity, to provide opportunities for increasing ethical knowledge, and to improve deliberation and justification skills (Buntting & Ryan, 2010).

South Africa is at the start of an entirely new chapter in the history of animal rights, human rights and social awareness. Being informed about scientific ethics is critical, not only for learners, students, researchers and educators but for all members of society. All South African citizens will occasionally make bioethical decisions as a result of today's biotechnology revolution.

Acknowledgements

The author wishes to thank Jacqui Sommerville in the Department of Statistics at the University of Pretoria for her constructive comments and stimulating feedback.

Endnotes

1. A term used in South Africa if people are trained in schools.
2. A term used in South Africa if people are trained in tertiary institutions.

References

- Animal Aid Education Department 2001. *Wasted lives: Student activities*. Kent: Animal Aid Education Department.
- Animal experiments: a reference guide for schools* 2000. London: British Union for the Abolition of Vivisection.
- Animal Studies Group 2006. *Killing Animals*. Urbana and Chicago: University of Illinois Press.
- Buntting C & Ryan B 2010. In the classroom: Exploring ethical issues with young pupils. In A Jones, A McKim & M Reiss (eds), *Ethics in the science and technology classroom*. The Netherlands: Sense Publishers.
- Capaldo T 2004. The psychological effects on students of using animals in ways that they see as ethically, morally or religiously wrong. *ATLA-alternatives to laboratory animals*, **32**: 525-531.

- Cohen L, Manion L & Morrison K 2007. *Research Methods in Education*. London and New York: Routledge.
- Conner L 2010. In the classroom: Approaches to Bioethics for senior students. In A Jones, A McKim & M Reiss (eds) *Ethics in the science and technology classroom*. The Netherlands: Sense Publishers.
- Department of Education 2002. *Revised National Curriculum Statement Grades R-9 (Schools) Policy, Natural Sciences*. Pretoria: Department of Education.
- Department of Education 2003. *National Curriculum Statement Grades 10-12 (Schools) Life Sciences*. Pretoria: Department of Education.
- De Villiers JJR & Monk M 2005. The first cut is the deepest: Reflections on the state of animal dissection in biology education. *Journal of Curriculum Studies*, **37**: 583-600.
- De Villiers JJR & Sommerville JEM 2005. Prospective biology teachers' attitudes toward animal dissection: implications and recommendations for the teaching of biology. *South African Journal of Education* **25**: 247-252.
- Downie R & Meadows J 1995. Experience with a dissection opt-out scheme in university level biology. *Journal of Biological Education*, **29**: 187-194.
- Hobsons Academic Relations 2001. *Finding out: About animals in medicines research*, London: Hobson's Academic Relations.
- Foster C, Stannistreet M & Boyes E 1994. Children's attitudes to the use of animals in education and research: what are their justification and reservations? *The School Science Review*, **76**: 39-44.
- Greenfield CL, Johnson AL, Shaeffer DJ & Hungerford LL 1995. Comparison with surgical skills of students trained using models or live animals. *Journal of the American Veterinary Medical Association*, **206**: 1840-1845.
- Guerrini A 2003. *Experimenting with humans and animals: from Galen to animal rights*. Baltimore, MD: Johns Hopkins University Press.
- Hopkins K 2008. *A legal argument against vivisection*. Retrieved on 14 January 2011 from <http://www.animalrightsafrica.org/VivisectionLegalArgument.php>.
- Horsthemke K 2010. *The moral status and rights of animals*. Porcupine Press: Johannesburg.
- Merikangas R 2011. *Students opposing vivisection*. Retrieved on 14 March 2011 from <http://www.animalrightsafrica.org/VivisectionStudentsOpposing.php>
- Mitchell G 1990. Procedures for the control of the care and use of animals for teaching and research. *South African Journal of Science*, **86**: 69-75.
- Orlans F B 1991. Forum: Dissection. The case against. *The Science Teacher*, **58**: 12-15.
- Pedersen H 2010. *Animals in schools: Processes and strategies in human-animal education*. West Lafayette: Purdue University Press.
- Pietersen J & Maree K 2008. Standardisation of a questionnaire. In K Maree (ed), *First steps in research*. Pretoria: Van Schaik Publishers.
- Reiss M 2010. Ethical thinking. In A Jones, A McKim & M Reiss (eds), *Ethics in the science and technology classroom*. The Netherlands: Sense Publishers.
- Smith A J & Smith K 2004. Guidelines for humane education: alternatives to the use of animals in teaching and training. *ATLA-alternatives to laboratory animals*, **32**: 29-39.
- Stannistreet M, Spofforth N & Williams T 1993. Attitudes of children to the uses of animals. *International Journal of Science Education*, **15**: 411-425.
- South African National Standard (SANS) 2008. *The care and use of animals for scientific purposes*. Pretoria: SABS Standards Division.
- Van Rooy W 1997. *Controversial issues and the teaching of A-level biology: possibilities and problems*. PhD thesis. Oxford: Oxford University.
- Vollum S, Buffington-Vollum J & Longmire DR 2004. Moral disengagement and attitudes about violence toward animals. *Society and animals*, **12**: 209-235.