

Enhancing Learning Through the Use of Animals in Undergraduate Biology Teaching: the Student Voice

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Abstract

The way in which society views the use of animals in university learning and teaching has changed dramatically in the last 30 years. A review of the literature shows that teaching academics who support the use of animals in learning and teaching counter arguments for effective alternative teaching strategies on the basis that in some situations there are no alternatives that provide students with the same skills and experiences. Debate by teachers and animal welfare advocates about the pros and cons of using animals in learning and teaching is widespread in the published literature, nationally and internationally, but rarely gives the students a voice. This study explores student perspectives on the use of animals in learning and teaching, and reports on a survey of students at three Australian universities. The results show that biology students value the authenticity of such experiences, the consolidation of theoretical learning, and the chance to use multiple learning modes via hands-on experiences. In particular, students see the benefits of such experiences as improving their understanding of biological concepts and opportunities for future employment.

Introduction

Most studies on the benefits of using animals and animal tissues to achieve learning outcomes in biology focus on a *teaching* perspective. These studies address how the use of animals allows teachers to convey or demonstrate important information and how well students subsequently perform in assessment tasks (Fawver, Branch, Trentham, Robertson and Beckett, 1990; Cross and Cross, 2004; Oakley, 2012). Fewer studies focus on the *student* perspective on the educational benefits to learning gained from using animal material (Downie & Meadows, 1995; Franklin, Peat & Lewis, 2001; Edwards & Jones, 2010; Elcoro & Trundle, 2013, Jones & Edwards, 2013). This is relevant, particularly in the modern environment, in which the call for animal-free learning activities appears ever louder. In 2009, we undertook a horizontal, cross-institutional study, seeking student perspectives on the value of using animals in learning biology. We investigated whether biology students in Australian universities, when given the opportunity to access and utilise animals and animal tissues, value and ascribe benefits to their learning from these experiences.

Review of literature

The use of animals in traditional undergraduate biology classes (e.g. behavioural studies, dissections, veterinary and medical school training) can no longer be assumed to be routine

and generally acceptable (Downie & Meadows, 1995; Franklin et al., 2001). Society's views on the appropriateness of such practices have changed since the 1980s (DeDecker, 1987, Keiser & Ham, 1991; Orlans, 1991; Ralph, 1996; Cross & Cross, 2004). Many members of the public are less accepting of past practices, including the use of animals for learning. It is important to consider that students may bring these perceptions with them into the classroom (Wheeler, 1993; Strauss & Kinzie, 1994; Ralph, 1996; Hagelin, Carlsson & Hau, 2000; de Villiers, 2012), declining to work with animal material on moral grounds.

There is a continuum of acceptable strategies around using animals or animal tissues in learning and teaching. These range from 'the alternative to dissection is ignorance' (Offner, 1993, p.148), to the considered use of a small number of preserved (reusable) or pest (killed for another purpose) specimens in demonstrations (Cunningham, 2003), through to animal-free alternatives (Fawver et al., 1990, Samsel, Schmidt, Hall, Wood, Shroff & Shumacker, 1994; Strauss & Kinzie, 1994; Greenfield, Johnson, Schaeffer & Hungerford, 1995; Hughes, 2000). What constitutes an acceptable strategy is difficult to determine but all animal-based activities must encompass the ideas of 'replace, reduce, refine' (Aust. Govt., 2013, p.9) espoused in The Australian Code of Practice for the Care and Use of Animals for Scientific Purposes. The Code of Practice also covers the use of animals in learning and teaching and requires that, while still addressing set learning outcomes, animal-based classes 1) replace animals with alternatives whenever possible, 2) reduce the number of animals used to a viable minimum and 3) refine procedures to minimise pain and distress to animals.

Despite several decades of debate, the higher education sector is still undecided on where on it is positioned on this continuum of acceptable strategies discovering that there is no 'one size fits all' way to address the issue. This is partly because when a student does not wish to use animal material and an alternative non-animal based task is offered this is classified as a non-essential use of animals in relation to the Code of Practice. Unfortunately, this kind of replacement does not always provide equivalent student experiences or assessable learning outcomes.

It is also difficult to determine whether there are currently more students in university biology objecting to the use of animals and animal tissues than in the past and whether a genuine shift in student attitudes has occurred. Changes to policies whereby institutions advise conscientiously objecting students to select other units and courses at the point of enrolment can remove those students from subjects and courses who would have otherwise been exposed to animals and animal tissues and make the real number of objections difficult to measure (United States of America, Cunningham, 2003).

Is it also unknown whether it is still acceptable to a majority of students to kill an animal 'just' to examine the digestive tract, or for fourth year veterinary students to kill animals as a part of practicing surgical techniques (Mangan, 2000) Or is there a minority of students who are becoming better informed and more vocal, thereby overshadowing the voice of the majority who still attach value to animal-based learning opportunities? Students themselves are rarely invited to give their perspective about whether the use of animal materials is helpful to their learning (de Villiers & Monk, 2005). There is merit in the argument for academic staff and students to meet regularly to review teaching approaches to ensure that student needs are being met (Franklin et al., 2001). The student perspective thus far has been mixed, and is usually based on the personal, moral or ethical position of individual students (Samsel et al., 1994; Mangan, 2000; Edwards & Jones, 2010). Interestingly, many students

support the idea of an opt-out option for classmates (Downie & Meadows, 1995; Mangan, 2000; De Villiers & Monk, 2005), despite wanting to participate in full themselves.

These finer distinctions parallel an increasing appreciation by the tertiary sector that in the sciences, including biology (McGlynn, 2008), there is now more content for students to learn than ever before (Ralph, 1996). What is required is a shift towards teaching less content and more skills such as information and technology literacy, problem solving and critical thinking. In a world in which information is now readily accessible electronically, many suggest that it is more important to teach students how to *find* and *use* information, than to cover all the detail in class. Some now advocate programs that teach science as inquiry (Kirkup & Johnson, 2013), focussing on ‘the need for students to experience the process of science in order to view science as a way of knowing, rather than a body of knowledge’ (Udovic, Morris, Dickman, Postlethwait & Wetherwax, 2002, p.272). Perhaps the content load could be reduced by acknowledging that not all students will need, for example, dissecting skills or detailed anatomical knowledge later in their careers (Franklin et al., 2001). Conversely, others argue that actually performing the experiment or dissection is an invaluable part of engaging in the *process* of science (Heron, 1992; Wheeler, 1993).

In response to changing societal attitudes about the use of animals and animal tissues, and what modern students *need* from a higher education, a number of universities in the United Kingdom, North America, Europe and elsewhere have formally or informally redesigned teaching curricula to include opt-out and alternative learning and assessment tasks (Heron, 1992; Pavletic, Schwartz, Berg & Knapp, 1994; Downie & Meadows, 1995; Mangan, 2000; Hedlund, Hosgood & Naugler, 2002; Shetty, 2011). This has led to considerable debate about whether equivalent learning outcomes (e.g. knowledge, skills acquisition, information literacy) can be achieved via these alternative activities (Modell, 1989; Franklin et al., 2001; Dewhurst, 2004). Alternative learning tasks often take the form of computer simulations (Strauss & Kinzie, 1994; Predavec, 2001; Dewhurst, 2004; Carroll, 2005; Peat & Taylor, 2005), the use of models (Greenfield et al., 1995; Hedlund et al., 2002; Carroll, 2005), bench-style chemistry experiments (Loureiro, Viana, Rodrigues, Cabral, Silva, Cardoso, Santos & Castro, 2004) or even self-experimentation (Van der Valk, Dewhurst, Hughes, Atkinson, Balcombe, Braun, Gabrielson, Gruber, Miles, Nab, Nardi, van Wilgenburg, Zinko & Zurlo, 1999). Many such studies conclude that if alternative tasks are appropriately designed, and learning objectives are clearly considered, students completing either the real animal or alternative tasks can achieve equivalent learning outcomes (Fawver et al., 1990; Samsel et al., 1994; Strauss & Kinzie, 1994; Greenfield et al., 1995; Hughes, 2000). Some authors, however, have reached the opposite conclusion (Duhkopf, 1998; Hughes, 2000; Cross & Cross, 2004). These contrasting conclusions perhaps reflect the need for more careful consideration of exactly what learning outcomes are desired from each task (Van der Valk et al., 1999), particularly given that today’s students are typically spending less time on campus, affording fewer face to face teaching opportunities (Villanueva, 2011). Lalley, Piotrowski, Battaglia, Brophy and Chugh (2010) recently found that different *aspects* of learning respond differently to virtual versus actual dissection experiences: students undertaking the virtual dissection performed better in immediate post-testing, but did not demonstrate improved retention. The debate continues, as biology teachers become more skilled at designing alternative learning tasks that address desired learning outcomes (Modell, 1989; Dewhurst, 2004; Allchin, 2005; Knight, 2007).

So why do teaching academics at some institutions continue to advocate so strongly for the use of animals and animal tissues as being beneficial (or even irreplaceable) to the student

learning experience? Many claim a broad range of benefits for students which are simply not achievable using alternatives. Some of the reasons they provide for experiences which use animals and animal tissues include realism (texture, smell, colour), authenticity (Herrington & Herrington, 2006 and references therein) and the development of skills which cannot be met by alternative tasks. Through observing and experiencing the natural variation in animals and animal tissues students realise that knowledge creation is a dynamic process (Pederson, 2002) and better understand the links between theoretical knowledge and practice (Table 1). It is certainly well established that when given the opportunity to investigate actively, many students engage far more effectively with hands-on activities supporting theoretical learning (Mayer, Bove, Bryman, Mars & Tapangco, 1996). Additionally, Hughes (1998) (cited in Pederson, 2002) advises of the value of students experiencing experiments that fail or give ambiguous data. Others protest the potential loss of animal material for less pedagogically-oriented reasons such as a dissection being an 'easy' way to teach biology (King, Ross, Stephens & Rowan, 2004) or a fear of loss of the ability to determine course content (Balcombe, 1997). Others remind us, however, that some students will, of course, go on to become animal researchers, and universities are obliged to teach them about their ethical responsibilities as wildlife (Monamy & Gott, 2001) or medical researchers.

Our responsibility to ensure that our biology students graduate with an awareness of the ethical responsibilities of people working with animals (DeDecker, 1987; Allchin, 2000) is not new, but is currently topical in the Australian university sector. The Australian Government is developing a new framework for regulation and quality assurance of higher education (Jones, Yates & Kelder, 2011). Threshold learning outcomes (TLOs) have been developed across all discipline areas, including Science (Jones et al., 2011). These TLOs describe the minimum levels of attainment for a suite of capabilities that science students from any Australian university should be expected to have achieved by the time they graduate. Threshold Learning Outcome 5 addresses Personal and Professional Responsibility (Jones et al., 2011). Section 5.3 specifically states that:

Upon completion of a bachelor degree in science, graduates will:

5. Be accountable for their own learning and scientific work by:
 - 5.3. Demonstrating knowledge of the regulatory frameworks relevant to their disciplinary area and personally practicing ethical conduct

Some authors feel strongly that the opportunity for students to discuss the ethics of animal use in both teaching *and* research is lost with the removal of animal material from classrooms (DeDecker, 1987; Allchin, 2000; Monamy & Gott, 2001; Pederson, 2002; Carroll, 2005; Pecore, Demitrikopoulos & Frantz, 2007).

It is clear that students are becoming increasingly informed and concerned about animal welfare and rights (Wheeler, 1993; Strauss & Kinzie, 1994; Ralph, 1996, Hagelin et al., 2000; de Villiers, 2012). Some students have requested, and more recently, demanded, learning activities that do not require the death of animals, specifically for the purpose of learning, or do not utilise animals or animal tissues at all (Heron, 1992; Pavletic et al., 1994; Strauss & McKinzie, 1994; Balcombe, 1997; Mangan, 2000; Cunningham, 2003). In some cases, this can be achieved with the use of preserved specimens, or by more careful choice of dissection specimens (e.g. the use of pest or invasive species) (Pavletic et al., 1994). The aim of this case study is to explore the perspectives of contemporary biology students on the use of animal material in their learning opportunities. We need such studies if we are to give students a voice on the nature of their learning experiences in university biology classes.

Table 1: A selection of the potential benefits of using both animals/tissues and alternative tasks in learning and teaching activities.

Benefits of using animals	References	Benefits of alternative tasks	References
Sense of personal discovery taps into increased engagement (secondary school), addresses multiple learning modes	Kinzie et al 1993; Offner 1993,; Krupa 2000; Carroll 2005; McGlynn 2008	Dissection can be emotionally disturbing	Orlans 1991; Samsel et al 1994
More realistic, develops manipulative skills, improves skills in use of scientific equipment	Peat and Taylor 2005	Dissection can harden attitudes and foster disrespect	Orlans 1991; Strauss and Kinzie 1991
Provides opportunity to examine personal values, reach a position and learn to defend it (secondary school)	DeDecker 1987; Allchin 2000; Monamy and Gott 2001; Pederson 2002; Carroll 2005; Pecore et al 2007	Upset students don't learn	Downie and Meadows 1995
Provides opportunity to learn how to apply theoretics knowledge in a practical context	Hughes 2000	Not all students need to acquire specific skills in e.g. dissection, so animals not unnecessarily killed	Dewhurst 2004; Peat and Taylor 2005
Provides opportunity to understand the methods by which science has produced knowledge and that understanding has practical limitations, appreciate that different knowledge is held with different degrees of confidence	Wheeler 1993	Learning in a virtual environment can be self-paced, simulations generate more data than real situations	Samsel et al 1994; Ralph 1996; De Villiers and Monk 2005
Have an awareness of variety and discrepancy in biological samples	Wheeler 1993	Cost and logistic challenge of providing animals increasingly challenging	Franklin et al 2001; Hedlund et al 2002; De Villiers and Monk 2005
Develops sense of "stewardship and appreciation for the unity and complexity of life" (secondary school)	Barra 2002	Avoid the negative experience of an unsuccessful experiment	Van der Valk et al 1999
Models/simulations have limits, difficult to transition to real life situations	Keiser and Hamm 1991, Hedlund et al 2002	Females (who may be more averse to vivisection) are not unfairly impacted	De Villiers 2012

Methodology

To measure student perspectives on the use of animal and animal tissues in biology students from two Australian universities (University of Tasmania (UTAS) and La Trobe University (LTU)) were surveyed in 2009 at the start of first year (early in Semester 1, prior to any animal-based practical classes), at the end of second year, and at the end of third year, before graduation (Table 2). Additionally, second year physiology students at the University of Melbourne (UMELB) also completed the survey (Table 2). All students in the three institutions undertake similar styles of Biology teaching programs, with a combination of lectures and animal-based practical classes, using mostly preserved animal tissue and histological specimens. Several dissection classes also occur each semester and students work with live animals (often invertebrates) to support their learning about structure and function, anatomy, physiology, ecology and cell biology. The majority of practical classes do not involve vertebrate animals being killed specifically for the purpose of learning, but rather use animals killed for other purposes (e.g. pests such as cane toads), and preserved specimens are reused year after year. At UTAS, students enrolled in the first year unit were from a mixture of bachelor degree programs including Science, Agricultural Science, Marine Science, Biotechnology and Medical Research. At LTU, first year students were from a similar mixture of degree programs including Biological Sciences, Animal and Veterinary Biosciences, Biotechnology and Cell Biology and Conservation Biology and Ecology. At both institutions it was also possible to enrol in the first year unit as an elective. University of Melbourne students were enrolled in a second year Animal Physiology unit as part of Bachelor of Science, Bachelor of Biomedicine and Bachelor of Agriculture degree programs.

Table 2: Enrolment numbers and response rates for each institution involved in the study (University of Tasmania: UTAS, La Trobe University: LTU, University of Melbourne: UMELB).

Institution	Year	Number enrolled	Surveys returned	Response rate (%)
UTAS	1 st	306	266	87
	2 nd	59	56	95
	3 rd	58	51	88
LTU	1 st	460	244	53
	2 nd	190	113	59
	3 rd	82	43	52
UMELB	2 nd	110	46	42

At all institutions, multipurpose paper surveys were administered to students in practical class sessions and participation was voluntary and anonymous. We administered paper, rather than online, surveys, to take advantage of the anticipated higher response rates (Nulty, 2009) and, therefore, to generate more numerous open-ended comments. Levels of student participation (%) for each year level at each institution were calculated as number of surveys returned

divided by the number of enrolled students. At the University of Tasmania, surveys were introduced by AE or SJ, and then administered by the senior demonstrator for each class, while at the UMELB and LTU, surveys were introduced and administered by practical class leaders not involved with this study. Surveys collected both qualitative and quantitative data using a combination of yes/no, four point Likert scale and open-ended questions designed to explore student perceptions about the benefits of the use of animals and animal tissues to their learning.

The survey contained eight questions, and some data have been reported elsewhere (Edwards & Jones 2010; Jones & Edwards 2013). The four survey questions used to generate data for this study are included in condensed form in Table 3. Data from separate institutions could not be pooled to examine patterns of responses across year groups, because Chi Squared analysis indicated several significant differences in the proportion of students responding to each question at various year levels among institutions. Results are, therefore, presented separately for each institution and patterns of responses are considered. Differences between year groups in the number of students responding to yes/no and Likert scale style questions were, then, examined by Chi Squared analysis for UTAS and LTU separately. University of Melbourne data were not analysed statistically. For four point Likert scale questions (Question 1: Extremely, Somewhat, Not very, Not at all helpful to learning; Question 2: Sometimes, Under controlled circumstances, Never, Always) the first two points were combined. For Question 3 the open comments were coded by AE using five categories (see Table 4). It was possible for students to make several comments here that could be coded separately, so comments in each category were converted to frequencies of total comments before Chi Squared analysis was undertaken. All statistical analyses were done using Excel 2010 and $\alpha = 0.05$ was used as the significance level throughout. Example comments are included to illustrate the main trends in student perceptions.

Table 3: Selected questions from the 2009 survey which explored biology student perceptions of the value of the use of animals and animal tissues to their learning in Schools of Biology or Zoology at three Australian universities. The original survey comprised eight questions and those relevant to the present study are presented in condensed form here.

	Wording of question	Form of response
1	<p>Do you feel that your learning experience was improved by the use of animals or animal tissues in that situation [previous study or work, including high school]?</p> <p>If yes, do you feel that your previous experiences using animals or animal tissues to aid your learning have been? Circle one.</p>	<p>Yes/No</p> <p>a) Extremely helpful to my learning b) Somewhat helpful to my learning c) Not very helpful to my learning d) Not at all helpful to my learning</p>
2	<p>Please select the most appropriate way to finish the following sentences:</p> <p>a) In my opinion, using animals or animal tissues (if the animal is humanely killed) for teaching and learning purposes, is acceptable (circle one):</p> <p>b) In my opinion, if animals are to be used the following would be the most appropriate:</p>	<p>Likert scale</p> <p>a) Never b) Sometimes c) Always d) Under controlled circumstances</p> <p>a) One specimen per student b) One specimen per small group of students c) One specimen per class (as demonstration done by teacher) d) Determined depending on type of activity</p>
3	<p>What benefits do you see or expect to gain from the use of animals or animal tissue in your learning in Zoology or Biology? Please list:</p>	<p>Open-ended, used to generate Table 4 and Figure 3</p>
4	<p>In your opinion, could equivalent skills and knowledge learned from using animals or animal tissues be gained in another way?</p> <p>If yes, please suggest one or more alternatives which you think would be appropriate:</p>	<p>Yes/No</p> <p>Open-ended</p>

Results and Discussion

We examined student perceptions of the benefits of using animal material as an aid to their learning by asking students:

“Do you feel that your learning experience was improved by the use of animals or animal tissues in that situation [previous study or work, including high school]?”

If yes, do you feel that your previous experiences using animals or animal tissues to aid your learning have been... Circle one of Extremely, Somewhat, Not Very, Not at all helpful to my learning”

All response rates were above 40%, and at UTAS they were 87% or higher (Table 2). At the two institutions, UTAS and LTU, for which a complete data set was available, the proportion of students who responded positively (Extremely + Somewhat helpful to learning) ranged from 50% in first year to 96% in third year at UTAS and from 65% in first year to 95% in third year at LTU. There were significant differences among year levels at both institutions (UTAS: χ^2 (df = 2) = 150.87, $p < 0.001$, LTU: χ^2 (df = 2) = 106.01, $p < 0.001$): the greatest proportion of students responded positively at third year level (Figure 1). The proportion of students who responded positively from the UMELB second year class was also high (91 %). These data provide evidence that students perceive that there *are* benefits to be gained from working with animal material, even at a first year level. An increasing appreciation of these benefits as students mature as learners from first to third year is particularly apparent at UTAS. Student comments about these perceived benefits also reflect this trend:

“first hand experience. Differs from learning from a book. It’s a mechanism that links a lot of the literature, pictures and teaching together” (first year UTAS student)

“to see things as they are in reality, as they work in the body” (second year UMELB student)

“...gave us an idea of how you would carry out studies in real life i.e. caring for animals, gathering behavioural data” (third year UTAS student)

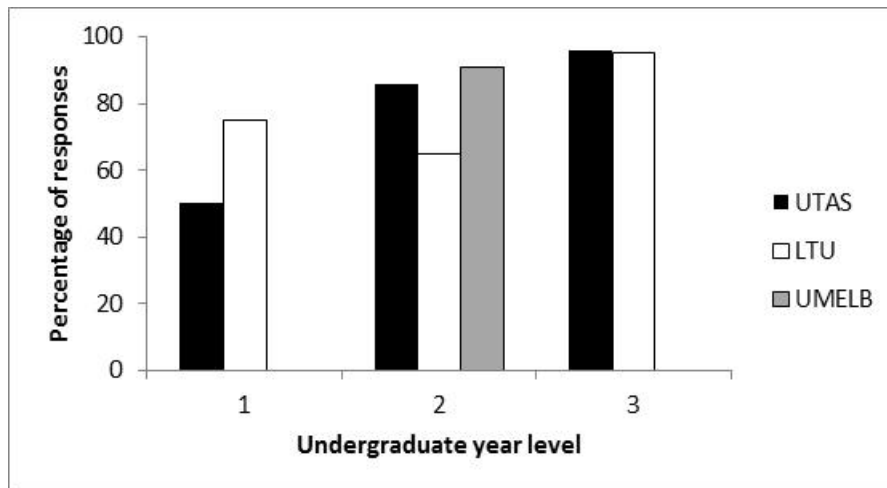


Figure 1: The percentage of students across year levels from the University of Tasmania (UTAS, black), La Trobe University (LTU, white) and the University of Melbourne (UMELB, grey) who reported that their previous use of animals or animal tissues was (extremely or somewhat) useful for their learning. For first year students their previous experience may have included high school learning.

Several other authors report that many students express great satisfaction from the hands-on experience involving animals (Peat & Taylor, 2005; Elcoro & Trundle, 2013) because it promotes engagement and student enquiry (Krupa, 2000). We also asked students to consider their position more deeply and from an ethical perspective:

In my opinion, using animals or animal tissues (if the animal is humanely killed) for teaching and learning purposes, is acceptable Sometimes, Under controlled circumstances, Always, Never (circle one):

A relatively high proportion of students at all year levels agreed that the use of animals or animal tissues was acceptable 'Sometimes' or 'Under controlled circumstances' (Figure 2). The proportion which agreed ranged from 84-93% at UTAS, 68-95% at LTU and 98% for second year students at UMELB. Responses to this question from both UTAS (χ^2 (df = 2) = 155.78, $p < 0.005$) and LTU students (χ^2 (df = 2) = 149.99, $p < 0.005$) differed significantly among year groups and in both cases the greatest proportion of students responding positively to this question was again at third year level (Figure 2). These results indicate broad acceptance of the use of animals and animal tissues in learning activities at all year levels. They also suggest that students are seeking assurances that the learning is relevant and authentic, and that the use of animal material is well-considered, purposeful and relevant. We received many comments supporting this finding:

[I would prefer to use] "already dead animals as opposed to those killed especially for the purpose" (first year UTAS student)

"I like being able to dissect the animals myself as I feel I learn more, however I like to know that they have been killed humanely" (second year LTU student)

Students indicated in open comments that they have concerns about the number of animals used in teaching, acknowledging the value of the activity, but at the same time seeking assurances that no more animals than necessary are used:

“I believe that when students are engaged in the learning experience i.e. actually want to learn, then use of animals or animal tissues can be valuable. However, I don’t believe that an animal is needed for every student” (third year UTAS student)

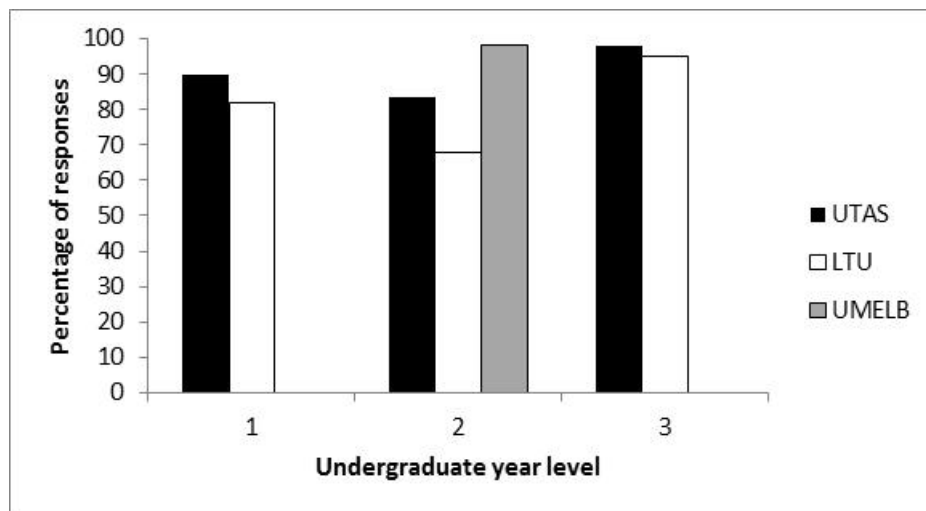


Figure 2: The percentage of students across year levels from the University of Tasmania (UTAS, black), La Trobe University (LTU, white) and the University of Melbourne (UMELB, grey) who agreed that the use of animals or animal tissues for learning and teaching is acceptable sometimes or under controlled circumstances.

These findings are well-supported by previous studies published a decade or more ago (e.g. Downie & Alexander, 1989; Hedlund et al., 2002; Smith & Smith, 2004). It is valuable to confirm that students today *still* feel this way. That is, they still desire and value opportunities to access animal material as part of an authentic learning experience, as well as the assurance that animal welfare has been considered.

To explore an aspect of these data more deeply, we asked students to characterise the benefits they believed they were gaining from the use of animal material:

What benefits do you see or expect to gain from the use of animals or animal tissue in your learning in Zoology or Biology? Please list:

Responses were coded using the five benefit categories in Table 4. They provided a rich and complex selection of perceived benefits attributed to the use of animal material during students’ learning. Frequencies of each type of response indicate that the students change their perspective on the benefits of using animals as they mature as learners (Figure 3). At first and second year levels, more students placed value on the authenticity of the learning experience, and the opportunity to consolidate theoretical learning (benefit 1):

“seeing internal structures of organisms and relating it to theory” (first year LTU student)

“text books and diagrams can be helpful but I think it is much more beneficial to look at the animal or animal tissue in real life” (second year UTAS student)

“learn to identify variety when identifying organs and other features rather than just seeing the perfect drawing in text books” (second year UMELB student)

By third year, however, students report gaining hands-on experience as a benefit of tapping into multiple learning modes (benefit 4) with increasing frequency. Open-ended survey comments linked this with opportunities to gain experience relevant to future employment (benefit 3). Some typical sentiments are included below:

“if your degree involves research, conservation in animal parks, management etc. all skills and knowledge about the animals and what happens to them, the respect they receive and the skills learned can all contribute to employment – a greater understanding will help make more appropriate decisions” (third year UTAS student)

“hands-on experiences – may aid greatly in future practices” (third year LTU student)

Previous studies have also suggested that the proportion of students favouring animal-based classes increased with year level (Smith 1994). Students feel better equipped to gain maximum benefit from such experiences later in their study program (Downie & Alexander, 1989; Hagelin et al., 2000) as reflected by some student comments:

“I enjoyed the practicals but...I think they would be of more use in later years when we really understand the theory” (first year LTU student)

“...save actual dissections for 2nd + 3rd year students” (first year UTAS student).

Further, several authors have previously suggested that only a small proportion of students will actually need to know how, for example, to dissect a rat in order to gain future employment (Ralph, 1996; Franklin et al., 2001; Dewhurst, 2004; Peat & Taylor, 2005). This sentiment is echoed by some students who were surveyed, and perhaps suggests that there is scope to reduce the number of animals used in teaching programs by sharing, working in groups, or using one animal as a demonstration.

“rather than multiple dissections, demonstrations...may be used” (second year LTU student)

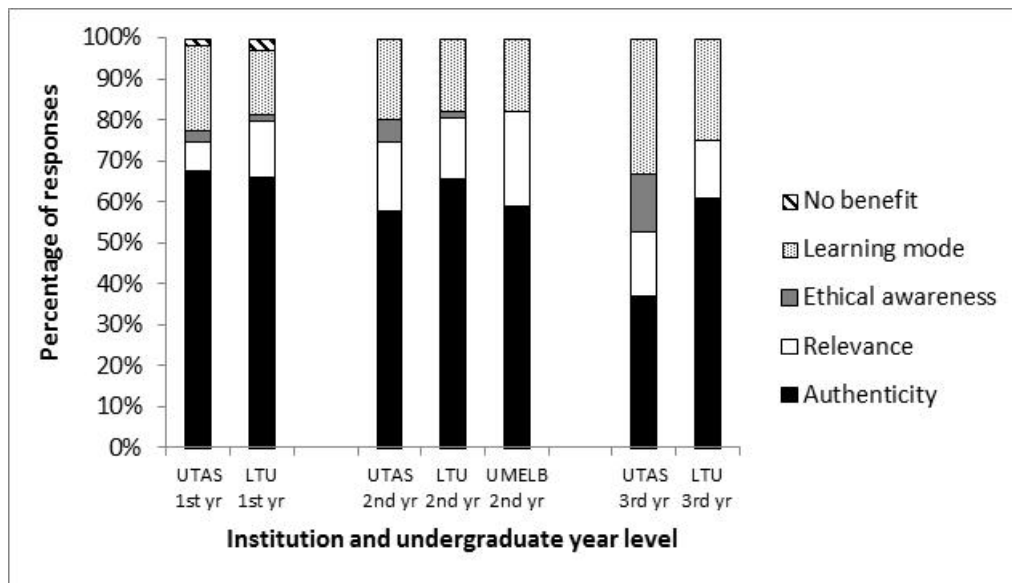


Figure 3: The percentage of different types of benefits of the use of animals and animal tissues in learning and teaching perceived by students across year levels from the University of Tasmania (UTAS), La Trobe University (LTU) and the University of Melbourne (UMELB). Full descriptions of benefit types 1-5 can be seen in Table 4.

These data, illustrating *current* student perceptions in Australian universities mirror the historical data reported in previous studies. This provides important context as we continue to consider the on-going value and viability of using animal material in Biology learning and teaching situations. We also asked the students:

“In your opinion, could equivalent skills and knowledge learned from using animals or animal tissues be gained in another way?”

“If yes, please suggest one or more alternatives which you think would be appropriate.”

The proportion of students from each year level who did not agree with the statement, that equivalent skills and knowledge could be gained via alternative tasks, ranged from 64-81% at UTAS and 61-79% at LTU (Figure 4). At both UTAS (χ^2 (df = 2) = 29.81, $p < 0.001$) and LTU (χ^2 (df = 2) = 77.13, $p < 0.001$) the proportion of students responding in the negative differed significantly among year levels, and increased overall from first to third year. Seventy-four percent of second year students at UMELB also responded in this way.

Table 4: Categories of student responses to the question ‘What benefits do you see or expect to gain from the use of animals or animal tissue in your learning in Zoology?’ Frequency data presented as Figure 3.

Type of response (category)	Includes such sentiments as:
1 Bringing authenticity to a learning experience	<ul style="list-style-type: none"> • putting theoretical learning into broader context • more interesting, memorable, engaging, realistic • appreciating individual variation/diversity • reinforces/complements lecture material • improving understanding of physiology, anatomy, behaviour
2 Seeing relevance of current learning to future and/or career options	<ul style="list-style-type: none"> • gaining practical skills including dissecting • become more comfortable handling animals • become more comfortable working with dead animals • being ready for expectations of future employment • being ready for tests/exams • preparation for honours or other research
3 Wanting to help others/animals/environment	<ul style="list-style-type: none"> • use of pest species instead of native animals • medical/vet studies/skills • develop ethical awareness/appreciation of animal(s)
4 Relating to learning mode - seeing, hearing, doing	<ul style="list-style-type: none"> • hands on experience/visual experience • tactile/textural experience
5 None/little/few	

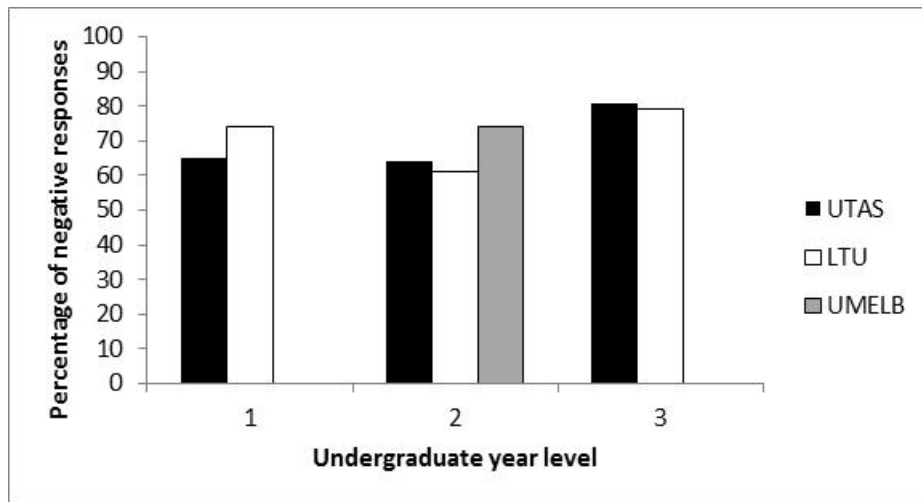


Figure 4: The percentage of students across year levels from the University of Tasmania (UTAS, black), La Trobe University (LTU, white) and the University of Melbourne (UMELB, grey) who did NOT believe that equivalent skills could be gained without using animals and animal tissues in their learning.

There were relatively few open-ended comments in response to the second part of this question, preventing valid statistical analysis (Table 5). Of those students who did respond, their suggestions were categorised as 1) static activities such as viewing images or looking at models, 2) interactive activities including computer simulations and videos and 3) using animals in a way that either reduced the number killed or reflected a desire to avoid animals killed for the sole purpose of learning and teaching.

Table 5 also indicates the proportion of students who responded positively to the statement that equivalent skills and knowledge could be gained in another way but then qualified their comment with the suggestion that they felt a compromise was being made with respect to authenticity, engagement or effectiveness, suggesting that the students felt that their learning experience could have been improved. For example:

“pictures can offer the same knowledge but not the same experience” (first year LTU student)

“in some cases computer programmes can be just as good as using animals. However, if you are planning on working in a field that deals with animals on a regular basis it would be better to have actual experience with them beforehand” (second year LTU student)

“animals used could be those that will be culled anyway (might be a purpose to death)” (third year LTU student)

“There are computer programs which allow ...however this may not be as effective in learning” (third year UTAS student)

Table 5: The percentage of total respondents (%) who proposed alternative strategies compared with using animals or animal tissues. The number in parentheses indicates the proportion of *those* respondents who qualified their response and suggested that the alternatives would not be as interesting, engaging or effective as the use of real animals or animal tissues for learning (University of Tasmania: UTAS, La Trobe University: LTU, University of Melbourne: UMELB).

Institution	First year	Second year	Third year
UTAS	31 (18)	32 (20)	19 (60)
LTU	18 (6)	27 (8)	14 (9)
UMELB		20 (38)	

Some authors have suggested that using animals can result in students becoming distressed, or developing a lack of respect for animal life (Orlans, 1991; Strauss & Kinzie, 1991; Samsel et al., 1994). Interestingly, one study compared differences in attitudes and learning outcomes between a dissection and a simulation. This study demonstrated no difference in understanding, but those students who completed the dissection became more positive about dissections, while those students who did the simulation became less positive (Strauss & Kinzie, 1994). Our findings indicate that students at the three universities surveyed value the opportunity to think about animal ethics issues and to have the opportunity to form an opinion of their own, as has been suggested by several other authors (DeDecker, 1987; Allchin, 2000; Barra, 2002; Carroll, 2005; Pecore et al., 2007). This is indicated by comments such as:

*“good to see instructors care for the wellbeing and efficient use of the animals”
(second year UMELB student)*

“using animals makes us think more ourselves about the animal ethics issues, which are likely to be important in our futures in this field” (third year UTAS student)

“needs to be carefully demonstrated and guided by lectures/prac demonstrators the give the animals the respect they deserve” (third year LTU student)

Some students in our study thought even more deeply about the ethical issues surrounding the use of animal material in learning and teaching situations, indicating an appreciation that

student feelings are likely to vary, and that the opportunity to develop and discuss an ethical position was valuable:

[it is appropriate to use animals] “in some cases. More importantly I think we need to learn more about why we are using animals, and even discuss this in practical groups with [a] demonstrator. We could discuss why we are using the animals, and if it could be learnt any other way and what exactly we are doing” (first year LTU student)

Conclusions

Newly designed Threshold Learning Outcomes for Science (Jones, Yates & Kelder, 2011) and, more specifically, for Biology (<http://www.vibenet.edu.au/home/draft-btlos>) require us to ensure that our students develop an understanding of the regulatory framework within which animal science is practiced, and that they personally practice ethical conduct. Our results clearly demonstrate that students understand the need for this awareness and professional practice. Our data also show that students are aware of the value of a learning environment that encourages them to develop and apply a personal ethical position regarding the use of animal material for learning, and that each individual’s personal position will fall somewhere on a spectrum of acceptability. Biology and Zoology undergraduate students still value authentic, animal-based learning opportunities, but academics and students alike are becoming more discerning about both the learning objectives and the issue of animal welfare. This has encouraged teachers and educational developers to carefully consider purpose, clarity and transparency when choosing to design, or redesign, and so advocate, animal-based learning activities.

The data from this case study indicate that undergraduate students increasingly perceive that there are benefits to their learning to be gained from using animals and animal tissues. The nature of this appreciation shifts as they mature as learners. Short term gains, such as passing a test or consolidating their understanding of facts was noted by first year students, while recognising the potential influences of current experiences on their futures was emphasised by third year students. Across all year groups, regardless of degree program (e.g. Bachelor of Agricultural, Marine or Veterinary Science), or institution, students advocate for authentic and relevant learning experiences *and* animal rights, by preferring learning tasks which consider welfare of animals, whilst still achieving desired learning outcomes. We conclude that there is strong support amongst biology students at these three Australian universities for the continued use of animals and animal tissues in learning and teaching, and that these students believe that such experiences form an important part of their training as the biologists of the future:

“I really think the use and interaction with animals has enhanced my learning hugely and made it feel more relevant, real and interesting” (second year UMELB student).

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