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Using animals in education as a means of discovering meaningful contexts to enhance learning and motivate learners: challenges and opportunities to integrate and broaden STEM education.

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Abstract

Through purposeful curriculum design educators can aim to capture both the hearts and minds of students and in doing so motivate them to persist in learning and deepen their knowledge and skills. Careful construction of learning activities that make meaning explicit to students and contextualizing knowledge within authentic learning scenarios can help promote intrinsic motivation for learning and integrate STEM. Examples of integrating the use of animals into learning activities are provided that illustrate some of the benefits and means by which this pedagogical strategy can be used to contextualize knowledge in ways that integrate wider considerations such as biological and behavioural processes, and potential implications for ethics, animal welfare, and regulatory issues. It also can help situate learning in a context that is meaningful for students, fostering motivation and deeper learning. Several examples of using animals either directly or indirectly to promote interdisciplinary learning are provided. While examples of using animals to achieve educational goals are highlighted, this model for improving learning and student motivation can be applied to other contexts that do not utilize animals. The use of animals either directly or indirectly provides valuable opportunities to integrate and broaden the application of STEM within education.

Introduction

The need to promote education in science, technology, engineering, and mathematics (STEM) has been emphasised in order to meet future expected employment needs (Gonzalez & Kuenzi, 2012). To facilitate this goal, it has been recognised that there is a need to broaden the scope of students' learning and to utilise real world situations and problems to help integrate STEM within existing curricula so as to make STEM subjects more relevant to both students and educators (National Research Council, 2014). Critical to this goal is the development of pedagogical practices that increase student interest and motivation (McDonald, 2016). Through such curriculum design educators can aim to capture both the hearts and minds of students for this purpose, motivate them to persist in learning, and generate interest and deeper learning within and across STEM education fields. Accordingly, curriculum design, when seeking to promote STEM education must be entrenched in building meaning as well as skills, and in contextualizing knowledge within authentic learning scenarios.

Within the veterinary degree program at James Cook University, animals are used to contextualize knowledge in a way that integrates wider considerations and implications and helps create authentic learning scenarios that foster motivation for students rather than aiming merely for students' knowledge acquisition. Knowing is linked to doing and the wider ethical, environmental and economic contexts through which knowledge application must navigate. Learning is fostered in an environment immersed in visual and tactile associations that can reinforce learning. While examples and challenges associated with using animals to achieve educational goals are discussed in this review, this same curricular/pedagogical model could be applied to other contexts that do not utilize animals to foster the integration of STEM, to broaden its application, and promote interdisciplinary learning. The author proposes that a key aim of curriculum design to promote interest and knowledge acquisition within the fields of STEM education is to identify and introduce a meaningful context. A meaningful context, within educational design, is defined as learning activities that contextualize the application of knowledge in a way that students can identify with, use their mistakes as learning opportunities, and come to appreciate wider contexts within which their knowledge is relevant.

Challenges in veterinary science education curricula

The challenge for most professional education programs is to provide training that is relevant for tomorrow's needs, that meets requirements set by professional accreditation bodies, and that attends to the needs of society. Unlike medical graduates who participate in internship, residency, and fellowship training on graduation, most veterinary graduates (approximately 70%) enter directly into clinical practice (Scalese & Issenberg, 2005). Veterinary graduates also have to often address problems across a range of domestic animal species. This requires a degree of omnicompetence on graduation and necessitates the need for competency-based education with a strong emphasis on the acquisition of skills to help ensure that graduates meet what are known as, day one competencies (Royal College of Veterinary Surgeons (RCVS), 2020).

Changes in demographics worldwide, with less students being exposed to agricultural practices, have meant that many newly enrolled students have not had broad exposure to domestic animals and animal associated industries. The majority of students entering veterinary training programs are from urban backgrounds and, as such, have had limited animal handling experience, particularly with large animals and small ruminants (Cawdell-Smith et al., 2007; Jelinski, Campbell, Lissemore, & Miller, 2008). Therefore, many hours within the veterinary curricula need to be devoted to animal handling and behaviour to scaffold the development of skills that are needed following graduation. Students must be trained to achieve competence in handling and restraining a variety of animal

species safely, to carry out diagnostic and surgical procedures, and to administer medications. Specific examples of the wide range of training provided within veterinary programs is beyond the scope of this chapter but can be found in several publications (e.g., Austin, Hyams, & Abbott, 2007; Cawdell-Smith et al., 2007; Chapman, Taylor, Buddle, & Murphy, 2007; Cockram, Aitchison, Collie, Goodman, & Murray, 2007; Smeak, 2007).

Of relevance to animals and topics covered within a modern veterinary education curriculum is the changing attitudes to animals within society that include greater concerns among consumers about animal welfare (George, Slagle, Wilson, et al. 2016) and increased awareness of the benefits and importance of the human-animal bond (Timmins, 2008). Recent expansion of the availability of diagnostic tests at the point of care, increases in pet ownership and in the availability of payment and pet insurance schemes have increased the demands for services and the range of services provided by veterinarians. Specialist services are now more readily available to the public and have increased in sophistication. These changes have required that veterinary education adapts to ensure that graduates' skills keep pace with the changing workplace so they can provide in-depth care and manage referrals.

The interconnectedness of humans, animals and the environment has in recent years led to the concept of One-Health being introduced into veterinary curricula. This introduction has resulted in additional opportunities for interdisciplinary learning as a consequence of the better appreciation of the wider impacts that animals can have on human health and the environment. A wide range of interconnected topics are also integrated into curricula to build more holistic training programs and work-ready, resilient graduates. These, for example, include teaching of handling and diagnostic skills, business skills, emotional resilience, and the ability to communicate with colleagues and a range of stakeholders (Favier, ten Cate, Duijn, et al. 2021; Pun, 2020; Schull, Morton, Coleman, et al. 2012). This diversification highlights the importance of situating curricula and education in STEM very much in the world that students will work in, and where employability and sustainability depends on students acquiring a wide skill set and range of competencies. It also emphasises the need for assessments that are relevant to, and verify job readiness. Veterinary curricula are, therefore, strongly focused on competency based education, which aims to ensure that students meet pre-set standards of competence by the time they graduate. This has resulted in increasing emphasis on developing communication and business skills, personal resilience, and training in the management of animal behavioural issues while still emphasising training in core skills which are known as day one competencies (RCVS, 2020).

Ethical issues related to animal usage

Ethical perspectives influence educational design and cooperation and participation of both educators and students in both STEM studies and in veterinary science. Use of animals for both education and research has been subject to controversy and differences of opinions (King, 2004; Phillips & McCulloch, 2005; Van Zutphen, 2002). Use of alternative, non-sentient objects and simulators is preferred by animal ethics committees, allowing expertise to be developed and errors to occur without imposing harm or stress on an animal (Noyes, Carbonneau, & Matthew, 2022). In a recent systematic review of humane alternatives to the use of animals for education within life and health sciences, humane teaching methods were found to produce learning outcomes superior (30%), equivalent (60%), or inferior (10%) to those produced by traditional harmful animal use methods, suggesting that humane alternatives represent valuable teaching alternatives in many contexts (Zemanova & Knight, 2021). The, so called Three R's (Reduction, Refinement and Replacement) were originally developed by Russell and Burch (1959) to guide the use of animals in research but these principles are also applicable to the use of animals for other purposes, including education. Attitudes differ on the use of animals for research and education. Prevalent views within the community range from complete exclusion of the use of animals to only using animals that have died of natural causes or those humanely euthanized when suffering from a terminal illness. Others support the use of animals that are surplus to requirements, the use of materials from abattoirs or the selection and the use of safe, tolerant and compliant animals that are maintained for teaching or research purposes (McGreevy, 2007).

Opinions on how humans can use animals are influenced by their ethical orientations. Lund, Kondrup, and Sandoe (2019) summarised a range of ethical views into four categories, animal rights, anthropocentrism, animal protection, and lay utilitarianism. Anthropocentrism, at one end of the spectrum, regards humans as being at the centre of the moral universe and animals are seen as a means to a human-centred end. At the opposite end of the spectrum, an animal rights perspective advocates non-human, sentient animals as having equal rights as humans; animals cannot be sacrificed for the sake of human interests. The animal protection orientation regards the use of animals for human purposes to be acceptable provided animals are treated humanely and do not suffer unnecessarily. Within this ethical orientation some form of suffering may be acceptable if considered necessary. Lay utilitarianism regards all forms of animal use as being acceptable as long as benefits to humans outweigh the disadvantages to the animals involved. This view posits that it is acceptable to cause animals intense pain and/or suffering for enabling outcomes that are sufficiently important to humans. In the study conducted by Lund, Kondrup, and Sandoe (2019) within the Danish population the animal protection orientation was the most prevalent, but the results also emphasised the diversity of animal ethics orientations that existed and which would likely exist in

any educational setting. Similar findings were reported in a study of the New Zealand population where 72% of survey respondents supported the use of animals for teaching purposes provided that there was no unnecessary suffering by animals (Williams, Dacre, & Elliott, 2007).

When using animals for educational purposes it is important to recognise that stakeholders may hold a range of views based on differing ethical principles. This might lead to differences in opinions and practices which may create tensions within educational teams and amongst students. It also means that, at times, both staff and students may conscientiously object to animal use for educational purposes (Knight, 2014). If such situations are not managed carefully, individuals might suffer academic sanctions while institutions might experience reputational damage. It is recommended that tertiary institutions should implement policies that make reasonable accommodations for students, staff, and faculty who conscientiously object to participating in activities that involve harmful animal use (Knight, 2014). As outlined by (Knight, 2014, p. 30) this will help promote,

“...a culture which is tolerant of diversity, and respects a range of viewpoints, beliefs and backgrounds. They can increase compliance with applicable legislation outlawing certain forms of discrimination in education or the workplace. They greatly decrease the likelihood of conflicts relating to curricular animal use, which can be extremely damaging to the careers of the students or others involved, and to the reputation of the university at large. And they maximise the likelihood of honest disclosure of student concerns, and of prior warning of incidents, and minimise crisis management or ad hoc responses.”

Wider considerations when using animals for education

The One Welfare concept extends the ethic of animal use to not only considering how animal usage should maintain animal welfare but also the welfare of owners/guardians and the environment (Pinillos et al., 2016). This concept situates animal welfare in a wider context that recognises the interconnectedness between animals, humans, and the environment in which they live. For example, when using grazing animals for educational purposes, maintaining animals on small areas of land can increase soil erosion and increase the risk of transmission of internal parasites and infectious diseases. Strategies, therefore, need to be in place to decrease the risk of both situations occurring while educational objectives are being achieved.

Animal usage can bring positive health benefits in addition to specific educational benefits. However, it can also result in unintended negative consequences for both animals and students. For example, positive benefits of enabling students to socialise with, care for, exercise, and groom animals can

include enhancement of the human animal bond. This can strengthen student empathy and values related to animal welfare and improve welfare outcomes for animals (Daly & Suggs, 2010). Alternatively, a reduction in empathy for animals and students' beliefs that some species of animals had lower levels of sentience was observed in some senior veterinary students in one study (Paul & Podberscek, 2000). In contexts where animals are used within rehabilitation programs, such as therapy programs for the disabled, in prisons, with people undergoing psychiatric or medical therapy, or with those confined in aged-care facilities, introducing contact with animals can help develop skills and be beneficial to the well-being of both humans and animals (Beck, Seraydarian, & Hunter, 1986; Lust, Ryan-Haddad, Coover, et al. 2007; Marr et al., 2000; Nimer & Lundahl, 2007; Pinillos et al., 2016). Potential disadvantages of bonding between people and animals can include students offering food items that are unsuitable or that do not meet an animals requirements. This can lead to ill-health, obesity, malnutrition, or gastrointestinal accidents. There may also be a reluctance to permit euthanasia on humane grounds and the expression of problem behaviours can also develop among animals (Wensley, 2008). Enabling animals to be able to voluntarily withdraw or have time out from contact to help avoid negative effects on animal welfare are also import to consider when using animals. Thus, there are broad considerations that can impact the physical and emotional health of animals that should be contemplated when using them for educational purposes.

Use of animals for educational and research purposes is strictly regulated through legislation (e.g., European Union, 1998; Qld Government, 2001; United States Department of Agriculture, 2019), codes of practice (e.g., National Health and Medical Research Council, 2013) and policies (e.g., Australian Veterinary Association, 2008; Animal Research Review Panel, 2019). Thus, any intended use of animals must comply with regulatory frameworks and ensure that animal welfare is maintained. Another factor to consider is the health safety of other animals and humans that might be impacted by the introduction of animals which could introduce infectious and zoonotic diseases. Facilities for housing and handling animals should be adequate and handlers must be suitably experienced to maintain adequate safety standards for students, instructors, and the animals. The financial cost of using and maintaining animals compared to non-animal alternatives (Knight, 2007) and the increased time needed to manage animals for educational purposes compared to alternatives should also be considered before using animals for educational purposes (Zemanova & Knight, 2021). The use of animals for educational purposes, therefore, requires detailed consideration of the resources available and whether animals can be ethically sourced, maintained, and retired at the end of a learning exercise, and that all aspects of management comply with existing regulations.

Educational advantages to using animals in education

Several advantages have been identified around the use of animals for educational purposes (Edwards, Jones, Bird, et al. 2014). Some advantages documented in the literature related to veterinary and non-veterinary education include:

- Introducing students to STEM research techniques by students designing and undertaking research to facilitate environmental enrichment for captive animals (Foerder, Farnsley, Hayes, et al. 2019).
- Increasing student empathy and socio-emotional development, developing compassionate values, and fostering moral awareness in elementary education (Daly & Suggs, 2010).
- Assisting students that are more oriented to kinaesthetic learning (Vemulapalli, Donkin, Lescun, et al. 2017).
- Stimulating interest in animal research and science and providing catalysts for children's creative writing pieces (Daly & Suggs, 2010).
- Helping to develop competencies in reading (le Roux, Swartz, & Swart, 2014) and social functioning (O'Haire, McKenzie, McCune, et al. 2013) in primary aged school children.
- Helping to develop knowledge and skills in the safe and humane handling of animals, knowledge of normal and abnormal behaviours, and improving diagnostic acumen (Cavalieri, 2009b; Chapman et al., 2007; Cockram et al., 2007; Sherman & Serpell, 2008).
- Providing opportunities to undertake diagnostic techniques, such as real time ultrasonography, which can better encourage the learning of anatomy compared to dissection (Bowman, Lawson, & Mckillup, 2016) and reinforce learning in anatomy (Ivanusic, Cowie, & Barrington, 2010).
- Helping students overcome fear and phobias and build confidence in animal handling (Chapman et al., 2007; Cockram et al., 2007).
- When compared to learning with the aid of simulators, the use of animals may be more appropriate for teaching complex, multifaceted skills and improving understanding and knowledge retention (Vemulapalli et al., 2017).
- Use as an aid to promote curriculum integration, creating links between foundational knowledge and its application and scaffolding the development of skill (Cavalieri, 2009a; 2009b).
- Fostering successful transition from high school to university and later years at university by including team work, participation in authentic learning scenarios and scaffolding learning (De Cat, Cavalieri, & Webster, 2014).

- Assisting with rehabilitation, intellectual and psychological disorders (Geist, 2011; Marr et al., 2000; Nimer, & Lundahl, 2007).

Thus, while the use of animals in education is contentious on one level and is subject to strict regulation, where animal usage can be managed within regulatory and ethical guidelines important educational benefits can be achieved including opportunities to broaden and integrate STEM education.

Using animals in education to uncover meaningful contexts enhance learning and motivate learners

Use of animals for educational purposes can introduce meaningful contexts which can enhance student enthusiasm and learning. This use is commensurate with the notion of threshold concepts in education which are described as concepts that open up new and illuminating ways of thinking about something and that provide frameworks for constructing knowledge and interpreting the world in ways that previously were not possible or were hidden from our understanding (Meyer & Land, 2003; 2005). Students who remain in a suspended state, without understanding a threshold concept can be described as, 'stuck,' (Meyer & Land, 2005) and being stuck may pose a barrier to the achievement of learning objectives (Cavaliere, 2009c). Consistent with a constructivist perspective, Doolittle (1999) stated that for learning to occur, "it must be relevant to the individual's current situation, understanding and goal" and when this occurs it "is likely to lead to an increase in motivation" (p.5). Similarly, when learning activities are immersed in meaningful contexts they provide opportunities for students to find purpose and meaning in their learning and, through this, generate intrinsic motivation for learning. Adopting this orientation advantages students, allowing them to build connections with their previous knowledge, experiences, and interests which helps create long-term, meaningful learning (Caballero, Meneses, Cano, et al. 2021). Novak (1993) argued that meaningful learning is, "fundamental to both the psychological process of cognitive development of individuals and the epistemological process of new knowledge construction" (p.1). It could, therefore, be argued that unless students find motivation in their learning experiences that deep learning will not occur and the opportunity to contextualise and create knowledge from related concepts might be diminished or lost.

Bretz (2001) described three conditions that must be satisfied for meaningful learning to occur. Firstly, a student must have some relevant prior knowledge to which the new information can be related in a non-arbitrary manner. Then, the material to be learned must be meaningful in and of itself; it must contain important concepts and propositions relatable to existing knowledge. Thirdly, a student must consciously choose to non-arbitrarily incorporate this meaningful material into their

existing knowledge. The first two prerequisites can be frequently met with learning exercises involving the use of animals. For example, before contact is made with an animal, students can receive pre-instruction on relevant aspects of behaviour, welfare, husbandry, and any required background information which might be relevant including instruction in any procedures that are to be carried out with animals. Critical in veterinary education and, arguably, other educational spheres is that the learning activity should involve exploration of real-world problems and development of skills that are applicable to professional practice and necessitate the use of animals. In this way the student is able to apply their existing knowledge and develop skill applicable to real world scenarios. The third requirement falls within the responsibilities of the student but it is critical to the achievement of a deep level of learning. Provision of an authentic context by designing activities that are rewarding and purposeful from a student's perspective should assist in them developing a deeper learning. At James Cook University we have utilised learning opportunities that mimic real world scenarios to improve student motivation. Students have reported that this has improved their learning and development of skills (Cavaliere, 2009b; 2009c). Several authors have reported on the importance of cultivating intrinsic motivation for enabling successful learning (Deci, Vallerand, Pelletier, et al. 1991; Glynn, Aultman, & Owens, 2005; Race, 2019). Designing learning activities that help motivate students can foster creativity, critical thinking, resilience and self-assurance, a greater sense of purpose, and autonomy (Chuter, 2019).

Novak's Theory of Human Constructivism states that "meaningful learning underlies the constructive integration of thinking, feeling, and acting, leading to human empowerment for commitment and responsibility" (Novak, 2003). The use of educational tools such as concept maps encourage meaningful learning through the application of this principle (Novak, 2002). Similarly, the use of animals may facilitate learning by engaging similar epistemological principles and promoting knowledge construction. By utilising animals, for example, the educator has the possibility of integrating a wider spectrum of information, and promoting deeper knowledge construction while potentially motivating students to enhance their learning. For example, in veterinary education at James Cook University, in an animal handling class that involves pigs and that aims to teach first year students aspects of porcine behaviour and safe handling techniques, a wider array of knowledge and skills have been integrated. In addition to handling skills, students are given the task of restraining, anaesthetising and recovering juvenile pigs under the supervision of a veterinarian. Through this learning exercise students learn important skills including how to: work together to achieve tasks, calculate dose rates in contexts where accuracy is vital, undertake venepuncture, administer injectable medications, monitor vital signs, and directly witness variations in responses to prescribed doses of medications and principles associated with induction of anaesthesia and recovery from

anaesthesia (Cavalieri, 2009c). This example illustrates how instruction in animal handling can easily be modified to incorporate opportunities for deeper learning. Other activities in which we use similar principles include the use of animals to highlight functional anatomy and physiology (Cavalieri, 2009a; 2009b) and promote a deeper understanding of research, animal nutrition, welfare, and statistical analyses through examining the effects of consumption of different diets on piglet growth performance (A. Malau-Aduli personal communication, August 17, 2021). The use of simulators has also provided opportunities to contextualise learning associated with animals, improve knowledge and skills without direct involvement with animals (Noyes et al., 2022). These learning opportunities involving animals or simulations can be used to cater to the epistemological process of new knowledge construction by immersing students in a context of tactile and purposeful knowledge construction. The use of animals in education then can provide a means for students to identify a range of interrelated concepts within a meaningful context as well as a way to develop a variety of skills that may be essential for required competencies.

Figure 1 summarises the concept of designing curricula to introduce meaningful contexts and, thereby, foster motivation and improved learning outcomes. While animals can be used as a means to improve learning other concepts and tasks can be substituted and introduced to create meaningful contexts. For example, skills in engineering and mathematics, along with working effectively in teams can be acquired when students are given tasks such as the design and construction of solar powered vehicles (Wellington, 1996).

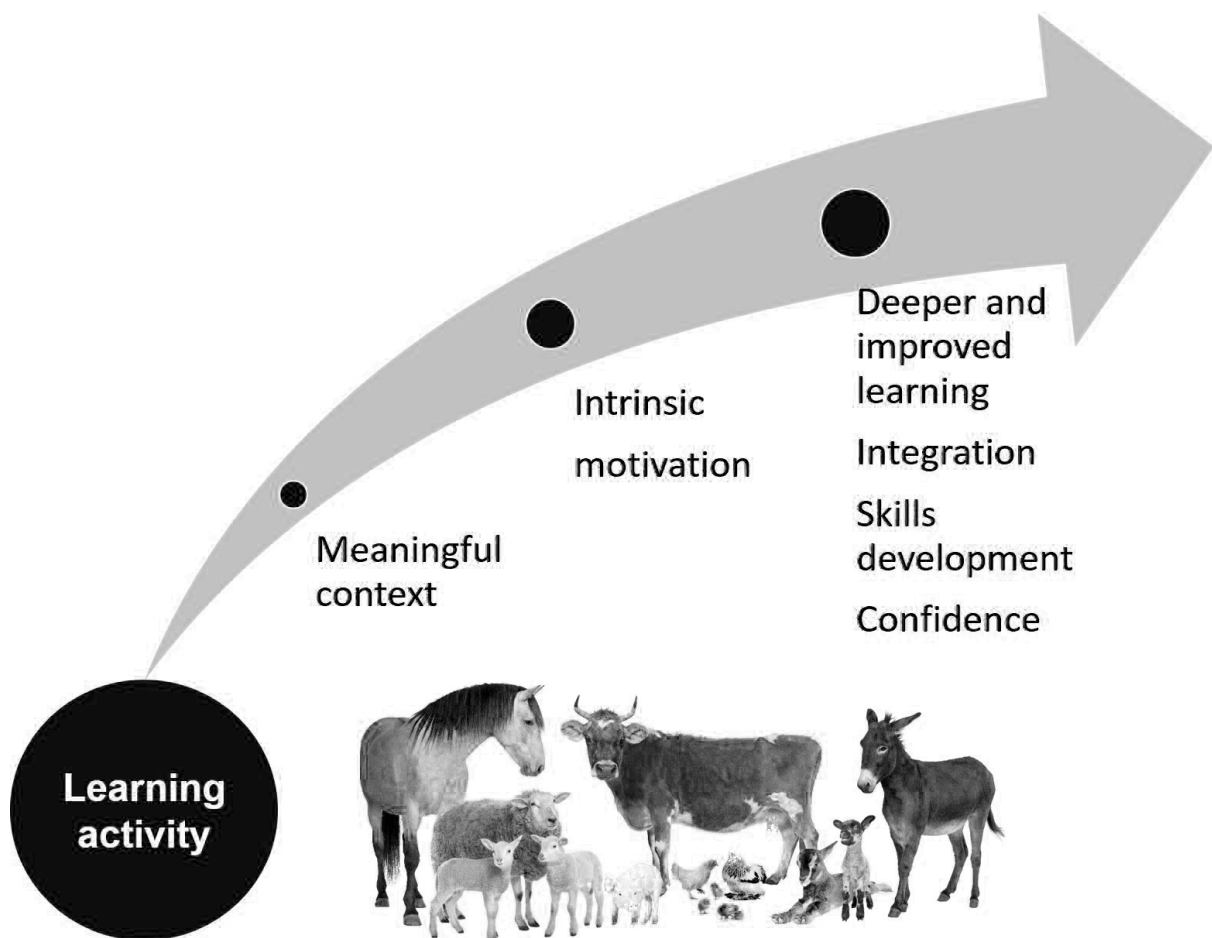


Figure 1. Integration of meaningful contexts to enhance learning through inspiring motivation and as a consequence deeper and improved learning outcomes. Animal image credit: Eric Isselee / Shutterstock.com.

Broader use of meaningful contexts to stimulate interest in STEM and success with tertiary education

Nakata et al. (2019) proposed and tested the use of pre-entry activities to increase preparedness of Indigenous students for tertiary studies and for improving transition to tertiary education and the likelihood of successful completions. One of these activities included the conduct of a short-term schools (5 days) for Indigenous secondary school students that is in operation at James Cook University within which they gain experience with a simulated tertiary experience. This school experience includes housing students within a residential college and providing them with a range of social and extracurricular activities. The students are also helped to learn to manage their time and develop their study skills as they complete an assessment task. The experience culminates with students participating in a simulated graduation ceremony. As part of this program animals are used,

with some students, to integrate study skills and wider knowledge acquisition. Students are lead through a case study involving an injured dog to introduce aspects of comparative anatomy which is reinforced through exposing students to both human and veterinary anatomy specimens. We introduce a SOAP (subjective, objective, assessment, plan) approach to aid in problem solving. We expose students to laboratory evaluation of blood and tissue samples and some principles of bandaging and surgery and underlying theory associated with imaging modalities such as CT, radiography and ultrasound (Figure 2). Students are given hands on experiences to reinforce principles taught didactically and through their research. Using a case-based approach to learning involving animals we are able to embed a meaningful context to introduce a broad range of interdisciplinary topics while avoiding any potential welfare costs or risks of students acquiring zoonotic infections by using animals directly.



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Figure 2. Within a residential school at James Cook University, Indigenous secondary school students are introduced to simulated case studies involving animals to promote interdisciplinary learning, study skills and a variety of career paths within veterinary and biomedical science.

In teaching other groups of students in the past, we exposed secondary school students to viewing parasites with microscopes to introduce potential zoonoses and parasite life cycles. Skulls from a range of different species have been used to highlight functional and comparative aspects of anatomy. An equine model for transrectal pregnancy diagnosis aroused considerable interest in students as they were introduced to a simulated experience of pregnancy diagnosis in horses and at the same time they are able to improve their knowledge of reproductive anatomy. This also provided them with an opportunity to experience a routine diagnostic task undertaken by veterinarians as they explored veterinary science as a potential career. Other activities included providing skeletal collections of dog bones for students to assemble without assistance and the application of ultraviolet illuminated cream to illustrate deficiencies in hand washing techniques. With early primary students we have used models of animal farms for students to construct housing conditions that provide what animals may need and used this to educate students about the five Provisions and aligned Animal Welfare Aims (Table 1) which provide a guide to optimising animal welfare (Mellor, 2016). The task of designing welfare audits for various animal environments can also be used as an opportunity for older students to understand and apply these important principles. Similarly, it is of interest that others have utilised digital gaming technology to improve knowledge of some aspects of animal welfare with primary school children (Hawkins, Ferreira, & Williams, 2019). These examples of activities that we and others have undertaken seek to introduce new knowledge within a meaningful context that stimulates student interest and motivation with the aim of improving learning outcomes and highlight the breadth of opportunities animals provide to promote learning and interest in veterinary science and STEM in general.

Table 1. Five Provisions and aligned Animal Welfare Aims (Mellor, 2016).

Provisions	Animal Welfare Aims
1. <i>Good nutrition</i> : Provide ready access to fresh water and a diet to maintain full health and vigour	Minimise thirst and hunger and enable eating to be a pleasurable experience
2. <i>Good environment</i> : Provide shade/shelter or suitable housing, good air quality and comfortable resting areas	Minimise discomfort and exposure and promote thermal, physical and other comforts
3. <i>Good health</i> : Prevent or rapidly diagnose and treat disease and injury, and foster good	Minimise breathlessness, nausea, pain and other aversive experiences and promote the

muscle tone, posture and cardiorespiratory function	pleasures of robustness, vigour, strength and well-co-ordinated physical activity
4. <i>Appropriate behaviour</i> : Provide sufficient space, proper facilities, congenial company and appropriately varied conditions	Minimise threats and unpleasant restrictions on behaviour and promote engagement in rewarding activities
5. <i>Positive mental experiences</i> : Provide safe, congenial and species-appropriate opportunities to have pleasurable experiences	Promote various forms of comfort, pleasure, interest, confidence and a sense of control

Conclusion

Education now and in the future should aim to incorporate a broad set of strategies that impart vocational, emotional and communication skills, resilience in the workplace, and the ability for self-care and management. Incorporating meaningful contexts into educational strategies can help to motivate students to learn and discover a range of interrelated concepts that lead students on a path of deeper learning and improve learning and interest in STEM. Animals provide a valuable aid to student learning and the opportunity to integrate a wide variety of concepts that are useful within a broader educational context, including STEM. Using animals for educational purposes must, however, be managed within acceptable ethical frameworks and comply with relevant legislation and regulations, but when possible provide valuable opportunities to enhance student learning, promote interdisciplinary education and provide a platform to integrate many aspects of STEM. Educators should strive to embed meaningful contexts into curricula designs to enhance student motivation and achieve learning outcomes so that the future STEM needs of societies are better and more easily met.

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