

# Perceptions of animal welfare and animal welfare curricula offered for undergraduate and graduate students in animal science departments in the United States

Sage Mijares, Paxton Sullivan, Catie Cramer, Noa Román-Muñiz, and Lily Edwards-Callaway<sup>1,✉</sup>

Department of Animal Sciences, Colorado State University, Fort Collins, CO 80523, USA

**ABSTRACT:** While perceptions of animal welfare have been assessed in veterinary students and students internationally, there remains a gap in research concerning undergraduate and graduate student perspectives of animal welfare in animal science programs at colleges and universities across the United States. A survey was developed to assess current animal science student perspectives of the importance of animal welfare as part of their education, their knowledge of available educational opportunities, and resources they think should be included in animal welfare curricula. An online survey was distributed to a national listserv of university administrators of animal science programs in the United States. A total of 624 survey responses were statistically summarized. Most respondents were undergraduate students (78.0%,  $n = 487$ ), between the ages of 18 and 24 (85.9%,  $n = 536$ ), and female (86.1%,  $n = 537$ ). Results indicated that despite most respondents not taking an animal welfare course previously (60.7%,  $n = 379$ ), most students strongly agreed that the inclusion of an animal

welfare course is an important part of the animal science curriculum (72.0%,  $n = 449$ ), that animal welfare is an important component of their education (63.1%,  $n = 394$ ), and that animal welfare courses would be helpful for their future careers (70.0%,  $n = 437$ ). When asked what attributes would be most important in an animal welfare class, students identified many different types of information and resources. The majority of respondents answered that discussing current hot topics in animal welfare (76.1%,  $n = 475$ ), ethical discussions (76.0%,  $n = 474$ ), and practical, applied questions (75.3%,  $n = 470$ ) were important course components. Suggestions for future research include investigating how animal science student perceptions change before and after taking an animal welfare course and exploring opportunities to expand formal welfare education in animal science departments. Inclusion of animal welfare into the curriculum is critical as many of the students currently enrolled in animal science departments will become the future stakeholders in animal-focused industries.

**Key words:** animal science, animal welfare, curriculum, education, graduate, undergraduate

© The Author(s) 2021. Published by Oxford University Press on behalf of the American Society of Animal Science.

This is an Open Access article distributed under the terms of the Creative Commons Attribution-NonCommercial License (<https://creativecommons.org/licenses/by-nc/4.0/>), which permits non-commercial re-use, distribution, and reproduction in any medium, provided the original work is properly cited. For commercial re-use, please contact [journals.permissions@oup.com](mailto:journals.permissions@oup.com)

Transl. Anim. Sci. 2022.5:1-9  
<https://doi.org/10.1093/tas/txab222>

## INTRODUCTION

Animal welfare has become increasingly important to agricultural industry stakeholders, including consumers, producers, veterinarians, researchers, policymakers, and others that have an

<sup>1</sup>Corresponding author: [lily.edwards-callaway@colostate.edu](mailto:lily.edwards-callaway@colostate.edu)

Received October 12, 2021.

Accepted December 4, 2021.

interest in the well-being of animals. Additionally, changing public perception of farm animal welfare and increased scrutiny regarding routine management practices have implications for those who develop standards for the care and use of food animals (Broom, 2010). Industry stakeholders have a shared responsibility to both humans and animals to improve welfare within production systems. However, perceptions of animal welfare are often influenced by personal values, attitudes, beliefs, and by many scientific, economic, and political factors, which ultimately impact the way industry stakeholders make welfare assessments (Lund et al., 2006; Fraser, 2008; Verbeke, 2009). Because attitudes, beliefs, and values are often shaped by education, the inclusion of animal welfare in animal science programs is critical to the development of future industry stakeholders.

The need for the inclusion of animal welfare courses and welfare-related training in veterinary medicine curricula has been recognized by prominent animal health organizations like the American Veterinary Medical Association (AVMA; Lord et al., 2017), the American College of Animal Welfare (ACAW, 2021), the American Association of Veterinary Colleges (AAVMC, 2018), the Federation of Veterinarians of Europe (FVE, 2019), and the World Veterinary Association (WVA, 2017). Despite this recognition, animal welfare is still primarily treated as an extracurricular discipline and not as a cornerstone of the veterinary school curriculum (Broom, 2005; Colonius and Swoboda, 2010). Recent studies have found that formal animal welfare education is still frequently lacking in veterinary school curricula (Shivley, 2016; Johnstone et al., 2019). The same recognition for animal welfare education in undergraduate and graduate animal science programs has not been widely identified. As of 2021, one author of this article (PAS) found that only 4 out of the top 10 land-grant universities in the United States, as determined by combining the 2021 Best National University Rankings (U.S. News, 2021) and NIFA's list of Land-Grant Colleges and Universities (NIFA, 2021) to select the first 10 mentioned, offered a graduate degree program in animal welfare. Of these same universities, 2 out of 10 had an animal welfare judging team and animal welfare club, and only 6 out of 10 offered a stand-alone animal welfare course, as determined by reviewing university websites and/or directly contacting departments. Land-grant institutions are colleges or universities in each U.S. state and many territories that traditionally have focused teaching, research, and extension activities on agriculture and mechanical arts (Croft, 2019),

thus emphasizing the importance of livestock welfare in the discussion of animal science curricula.

Multiple studies have been conducted with veterinary students to assess their perspectives and knowledge about animal welfare (Colonius and Swoboda, 2010; Hazel et al., 2011; Abood and Siegford, 2012; Proudfoot and Ventura, 2021); however, a research gap still exists regarding undergraduate and graduate animal science student perspectives of animal welfare. This research gap is notable because animal science students represent future industry stakeholders who will assess current animal welfare issues and form solutions to a wide range of welfare challenges relevant to food animal production; therefore, their exposure to animal welfare education during their undergraduate and graduate studies is critical. Furthermore, there is a lack of information regarding the application of formal welfare education in animal science departments and student perception of such classes in animal science curricula. A three-decade-old study about teaching welfare in land-grant universities suggested that colleges and universities must provide students with education about standard animal husbandry practices and welfare so that they can address challenges facing agriculture, including attacks from animal rights activists (Friend, 1990). Since then, the goal of formal animal welfare education in universities has shifted from providing students with the ability to respond to activists to providing students with the skills necessary to assess and solve emerging welfare challenges effectively. The growth of animal welfare education in higher education and the evolution of its teaching objectives has been influenced by developments in the field of animal welfare science, growing public concern about farm animal welfare (Broom, 2010), and the increasing importance of animal welfare science to specialties in the field of animal production, including to veterinary medicine.

The purpose of this study was to identify animal science undergraduate and graduate student perspectives of the importance of animal welfare as part of their education, their knowledge of animal welfare educational opportunities available to them, and resources they think should be included in animal welfare curricula. Although the authors recognize that animal welfare is critical to all animal industries (e.g., lab, zoo, and companion animals), this particular manuscript was written with a focus on livestock animal welfare as livestock production management is a significant component of animal science education.

## MATERIALS AND METHODS

The study materials and research plan were approved through the Colorado State University (CSU) Institutional Review Board (#21-10558H) prior to project initiation. This article represents a portion of the survey results.

### *Study Population and Recruitment*

The population of interest for this study was undergraduate and graduate students enrolled in animal science departments at colleges and universities across the United States. An invitation to participate in an online survey was sent to members of an electronic mailing list for animal science administrators. The members were chairpersons from university animal science departments across the United States; the electronic mailing list included 84 unique email addresses but likely there were multiple individuals from the same university represented. The invitation requested that the survey be shared with undergraduate and graduate students within the departments that the administrators represented. The email included an invitation to participate in the online survey and a direct survey link. A \$25 gift card incentive was offered to the first 100 participants who filled out the survey completely. Participants who wanted to be considered for the gift card incentive were asked to leave their emails in a separate survey. No identifying information, including emails, was associated with survey responses. Forced response questions included consent to participate and identifying if the student was a part of an animal science degree program. All other questions were optional and could be skipped by the respondent. The survey remained open for 2 weeks and no reminders were sent.

### *Survey Development and Content*

A survey regarding student perceptions of animal welfare was developed by investigators who had expertise in animal welfare and survey question development. The survey was developed in Qualtrics survey software (Qualtrics, Provo, UT) and pretested by 10 individuals from the CSU College of Veterinary Medicine and Colorado School of Public Health. The 10 individual pre-testers were familiar with the survey topic but ineligible to participate in the actual survey as they were not in animal science degree programs. The final survey consisted of 46 questions; however, a variable number of questions was displayed for different participants due to branch logic used within the

survey. The survey was intended to take 30 min or less to complete. A variety of question types were asked including multiple choice, Likert scale, and open-ended. Questions were grouped into three categories: demographic questions, animal welfare curricula, and perceptions of animal welfare. Definitions of terms were not provided in the survey. The survey is provided in [Supplementary Material](#).

### *Statistical Analysis*

Once the survey was closed, all data were exported from Qualtrics to a Microsoft Excel spreadsheet (Microsoft Corporation, Redmond, WA). Surveys that were <80% complete were not included in the analysis. Nine hundred twenty-nine surveys were returned with 624 surveys being >80% complete. Descriptive statistics were tabulated in Excel for all variables of interest. Results are reported as (*n*, percentage) unless otherwise noted.

## RESULTS

### *Demographics*

A total of 624 surveys were included in the analysis. Respondents represented 23 universities in 21 states, 20 of which were land-grant institutions. Estimating an actual response rate is a challenge as the survey was sent to administrators in animal science departments with the request to share with student populations.

Respondent demographics are summarized in [Table 1](#). The majority of respondents were between the ages of 18 and 24 (536, 85.9%), and female (537, 86.1%). Most of the respondents were nonvegetarian (537, 86.1%). The majority of respondents were undergraduate students (487, 78.0%) while 10.9% (68) were enrolled in a master's program and 9% (56) were enrolled in a PhD program. Slightly less than half of students were from a suburban background (287, 46.0%), while 42.3% (264) were from rural backgrounds and 9.9% (62) were from urban backgrounds.

### *Animal Welfare Background*

The majority of survey respondents had not taken an animal welfare course previously (379, 60.7%). All respondents stated that they knew what type of animal welfare education or opportunities were offered at their universities. In a "select all that apply" question, respondents indicated that most animal welfare education opportunities were offered

within their animal science departments, with the most common offering being an animal behavior course (522, 83.7%), followed by an animal welfare course (444, 71.2%), and a combination animal welfare/behavior course (360, 57.7%). Less than half of respondents (244, 39.1%) stated their universities had animal welfare judging teams within the animal science department, 31.9% (199) had animal welfare clubs, and 29.3% (183) of respondents reported their universities having graduate programs in animal welfare. Opportunities that were offered outside of animal science departments included animal welfare clubs (42, 6.7%), animal behavior courses (24, 3.8%), graduate degree programs in animal welfare (19, 3.0%), animal welfare courses (15, 2.4%), animal welfare judging teams (14, 2.2%), and combined animal welfare/behavior

courses (9, 1.4%). Respondents were asked what resources they would utilize if they had a question about animal welfare; several options were provided and there was the opportunity to provide other resources not listed (Table 2). The majority stated they would use livestock/veterinary associations (540, 86.5%) and peer-reviewed publications (514, 82.4%). Greater than half would utilize an extension website (340, 54.5%), and 38.3% (239) stated they would use the Humane Society of the United States. Less than one-third would use a general web search (182, 29.2%) or peers or relatives (132, 21.2%). A small minority (35, 5.6%) stated they would utilize social media if they had a question about animal welfare. Among the respondents who chose the category “other,” popular responses included consulting professors or faculty (38, 6.1%) or veterinarians (10, 1.6%).

**Table 1.** Demographic summary ( $N = 624$ )

Demographic	<i>n</i> , %
Age	
18–24	536, 85.9
25–34	78, 12.5
35–44	6, 1.0
45–54	3, 0.5
55–64	1, 0.2
Gender	
Female	537, 86.1
Male	77, 12.3
Non-binary	10, 1.6
Current degree program	
Undergraduate	487, 78.0
Masters	68, 10.9
PhD	56, 9.0
Other	13, 2.1
Community type	
Rural	264, 42.3
Suburban	287, 46.0
Urban	62, 9.9
Undefined or other	11, 1.8

### Importance of Animal Welfare

Table 3 summarizes responses to multiple survey questions regarding student perceptions of the importance of animal welfare. A large majority of survey respondents either strongly agreed or agreed with the statement “*it is important to have*

**Table 2.** *If you had a question about animal welfare, which of the following resources would you use? Select all that apply (N, %)*

Peer-reviewed publications	514, 82.4
Extension website	340, 54.5
Livestock/veterinary associations	540, 86.5
Humane Society of the United States	239, 38.3
General web search	182, 29.2
Social media	35, 5.6
Peers or relatives	132, 21.2
Other, please specify	73, 11.7
No answer	1, 0.2

**Table 3.** Importance of animal welfare statements

Question	Strongly agree <i>n</i> , %	Agree <i>n</i> , %	Neither agree nor disagree <i>n</i> , %	Disagree <i>n</i> , %	Strongly disagree <i>n</i> , %	Blank <i>n</i> , %
<i>It is important to have an animal welfare course as part of the animal science curriculum.</i>	449, 72.0	158, 25.3	14, 2.2	2, 0.3	1, 0.2	0, 0.0
<i>Animal welfare is an important component of my education.</i>	394, 63.1	177, 28.4	42, 6.7	11, 1.8	0, 0	0, 0.0
<i>Animal welfare courses would be helpful for my future career.</i>	437, 70.0	157, 25.2	22, 3.5	8, 1.3	0, 0	0, 0.0
<i>Concepts related to animal welfare are integrated in other courses in my degree.</i>	282, 45.2	235, 37.7	75, 12.0	29, 4.6	3, 0.5	0, 0.0
<i>If I was faced with an animal welfare dilemma, I would feel confident addressing the issues.</i>	189, 30.3	345, 55.3	73, 11.7	14, 2.2	2, 0.3	1, 0.2
<i>I feel confident I know how to research and discuss an animal welfare topic, even one that I know very little about, in order to form an educated opinion that I can communicate to others.</i>	249, 39.9	326, 52.2	37, 5.9	10, 1.6	2, 0.3	0, 0



an animal welfare course as part of the animal science curriculum” (449, 72.0% and 158, 25.3%, respectively). More than half of the respondents (394, 63.1%) strongly agreed “animal welfare is an important component of my education,” and 70.0% (437) strongly agreed “animal welfare courses would be helpful for my future career.” When asked if concepts related to animal welfare were integrated in other courses in their degree, 45.2% (282) agreed strongly and 37.7% (235) agreed. Approximately half of the respondents (345, 55.2%) agreed with the statement “If I was faced with an animal welfare dilemma, I would feel confident addressing the issues” while 30.3% (189) of students agreed strongly. In response to the question “I feel confident I know how to research and discuss an animal welfare topic, even one that I know very little about, in order to form an educated opinion that I can communicate to others,” 39.9% (249) of respondents strongly agreed, and 52.2% (326) agreed.

When asked to select all attributes that would be most important in an animal welfare course given a list of possible items, students believed many attributes to be important including ethical discussions (474, 76.0%), hands-on application (435, 69.7%), practical, applied questions (470, 75.3%), understanding species differences (457, 73.2%), and discussing current hot topics in animal welfare (475, 76.1%) (Table 4).

## DISCUSSION

While perceptions of animal welfare have been assessed in different groups including veterinary students (Abood and Seigford, 2012; Johnstone et al., 2019; Proudfoot and Ventura, 2021) and students internationally (Freire et al., 2017; Mota-Rojas et al., 2018; Vargas-Bello-Pérez et al., 2021), there is still a lack of research regarding undergraduate and graduate animal science student perspectives of animal welfare as part of their education in the United States. Although there has been growth in the number of faculty members at

**Table 4.** If you were to take an animal welfare course, which of the following attributes would be most important? Select all that apply (n, %)

Ethical discussions	474, 76.0
Hands-on application	435, 69.7
Practical, applied questions	470, 75.3
Understanding species differences	457, 73.2
Discussing current hot topics in animal welfare	475, 76.1
Other, please specify	32, 5.1
Blank	3, 0.5

universities specifically trained in animal welfare science (Broom, 2005), the field is still novel and expanding relative to other more traditional animal science specialty areas, for example, nutrition, genetics, and meat science.

The population of survey respondents consisted of a greater percentage of female students as compared with published enrollment trends for degree-granting institutions in the United States, with 86.1% of survey respondents being female while 57.4% of students enrolled at universities nationally are female (NCES, 2019). Survey respondents were slightly younger than students nationally, with 85.9% of survey respondents aged 18–24 while 74.5% of students nationally are between 18 and 24 (NCES, 2019). Some differences in the study population compared to the national population of students may be due to demographic differences present in animal science departments specifically as compared to overall university statistics. While limited data exists on comparable animal science student populations, Parrish et al. (2015) found that students in animal science undergraduate programs in the United States were typically from non-agricultural backgrounds and approximately 75%–80% female. Similarly, the animal science students who responded to this survey were majority female (537, 86.1%) and from a suburban background (287, 46.0%). The AVMA recently reported that in 2019, 63% of the active veterinary workforce was female (AVMA, 2020). Speculations as to why veterinary medicine has become a female-dominated field include the elimination of gender discrimination during admission, an increase in the number of female role models (particularly in the physically demanding parts of the profession), an overall improvement in restraint methods for large animals, and the caring image of veterinarians depicted in media (Lofstedt, 2003). The distribution of veterinary school graduates in livestock versus companion animal practice may also be dependent on gender, as shown by a 2012 survey (Shepherd and Pikel, 2012). Results of this survey show that only 4.4% of female graduates enter “large animal exclusive” or “large animal predominant” practices, compared to 13.4% of male graduates (Wise and Gonzalez, 2002).

Animal welfare is an important topic that garners significant attention in public forums, as was reflected by the abundant and rapid response to the survey; it should be noted, though, that the response time was also likely influenced by the offered incentive. Although it is a challenge to estimate response rate due to the nature of survey distribution, the

number of responses received was considerable and is likely a testament to the value that people place on animal welfare. Twenty-three universities were represented in the survey responses, likely providing a diverse sample of department cultures, curriculums, and views on animal welfare. Many other universities could have potentially participated in the survey, as there are 93 universities or colleges in the United States that offer an animal science major ([U.S. News and World Report, 2021](#)) and many of them were included in the survey distribution list. The number of responses received, or universities represented, could have potentially increased if the study authors sent reminders to participate or connected directly with universities instead of distributing the survey through an electronic mailing list. The considerable response to this survey identifies more opportunities for further exploration into student perceptions about animal welfare and those that differ across universities.

Animal welfare is an integral component of livestock production ([Hewson, 2003](#); [Fraser, 2008](#); [Verbeke, 2009](#)), as it is in all animal-focused industries. Although some animal science departments may include coursework on a diversity of animal types, traditionally these departments have a strong focus on livestock production management, thus the focus of livestock welfare in this study. In this study, most survey respondents believed that their universities integrated animal welfare into other courses within the animal science degree program. This survey did not ask respondents to provide details about the way animal welfare was addressed and included in non-welfare-specific courses, but this would be an interesting area to investigate further. There are many different components to defining, measuring, and assessing animal welfare and likely the way specific animal welfare topics are integrated into course material varies greatly by individual instructor and institution, among other impacting factors. Even for animal welfare-specific courses, there currently is no standardized guidance on the critical elements to include in a course for undergraduate and graduate students. To address the need for comprehensive animal welfare education for veterinary students, a working group of experts developed a model curriculum for the study of animal welfare in colleges and schools of veterinary medicine defining curriculum objectives, describing core competencies, and identifying instructional resources ([Lord et al., 2017](#)). A complementary resource to support welfare education for undergraduate and graduate students has not yet been developed but would be beneficial, particularly

as the presence of animal welfare courses within animal science departments continues to grow.

Several questions in this survey aimed to identify what experience students had with animal welfare courses and extracurricular activities and what types of animal welfare opportunities were offered at their universities. All respondents stated they knew what type of animal welfare education or opportunities were offered at their universities. This widespread awareness of welfare programming within the study population could reflect students' interest in the topic and departments' engagement with the topic. The majority of respondents indicated that their animal science departments offered an animal behavior course and/or an animal welfare course. However, it is important to note that not all universities offer these courses, and results of the survey only represented 23 universities that have animal science programs. The large percentage of respondents indicating their universities offered these courses may be unique to the study population, with fewer survey respondents representing schools who did not have animal welfare education opportunities. Additionally, the universities that shared the survey with students may generally be more supportive of animal welfare programming, as seen by their willingness to share the survey opportunity, thus biasing the sample population. Interestingly, while courses in animal welfare seemed widely offered at the participating universities, the majority of survey respondents had not taken an animal welfare course previously. Several studies assessing veterinary student perspectives about the value of an animal welfare course before and after enrollment have shown generally positive responses, indicating improved confidence in researching and assessing welfare scenarios, increased agreement that an animal welfare course is a valuable component of the curriculum, and improved ability to identify and discuss ethical dilemmas ([Lord and Walker, 2009](#); [Abood and Seigford, 2012](#); [Johnstone et al., 2019](#)). This survey did not ask students why they had or had not taken a welfare course, though this would be valuable information to request in future surveys. Considering many students felt animal welfare was integrated into other animal science coursework they were exposed to, their desire or perceived need to take an animal welfare-specific course was perhaps decreased. Furthermore, respondents who had a strong interest in or awareness of animal welfare were likely more inclined to take the survey, which could potentially introduce bias into the sample and explain the large proportion of students who felt comfortable discussing

animal welfare, perhaps not capturing the views of all animal science students.

Despite the fact that most respondents had not taken an animal welfare course previously, students seemed enthusiastic about the topic of animal welfare as the vast majority agreed that animal welfare was an important component of their animal science education. When asked what types of information should be included in animal welfare courses, respondents selected many of the options provided, including ethical discussions and discussions on current animal welfare challenges. Several studies have focused on integrating different teaching strategies into animal welfare instruction for both veterinary and undergraduate students to promote learning and knowledge retention. There has also been some focus on utilizing online modules to be able to provide animal welfare education to a wider audience, both nationally and globally (Siegford et al., 2005, 2010; MacKay et al., 2016). Other teaching strategies that have been explored include active learning, moderated discussion of current welfare topics, frame reflection assignments, peer instruction, and participation in an animal welfare judging competition (Heleski et al., 2003; Lord and Walker, 2009; Lord et al., 2010; O'Malley and Siegford, 2018; Proudfoot and Ventura, 2021). Studies have shown that student performance on examinations improved with active learning compared to passive learning (Freeman et al., 2014; Deslauriers, 2019) and therefore many of the listed teaching strategies may be effective ways of teaching students about animal welfare concepts. Many students who took the survey indicated they wanted ethical discussions to be a component of animal welfare courses. This is an important consideration and adds evidence for needing guidelines and more data or research about effective ways to teach animal welfare.

Many students felt confident addressing animal welfare issues despite not taking a class previously. The poor accuracy of self-evaluation might explain this finding. Self-assessment of competence is a difficult task and students often self-assess their proficiency in various skills as significantly greater or lesser than their true level of proficiency (Carter and Dunning, 2008; Isenberg et al., 2015). Students surveyed indicated that they would research animal welfare topics using varied but not always reputable sources including general web searches, peers or relatives, and social media. This aligns with research indicating that students use social media as a primary information source for animal welfare topics (Colonius and Swoboda, 2010; Vargas-Bello-Pérez et al., 2021). While social media is a platform

used by animal welfare groups to raise awareness and promote discussion of animal welfare topics (Sisson, 2017), information on social media may be biased and should be evaluated cautiously and with other types of resources. Including information on how to research animal welfare topics would be a useful topic to include in animal welfare courses.

In addition to classroom opportunities for teaching students about animal welfare, one opportunity that is being integrated into many land-grant institutions' extracurricular programming is participation in an animal welfare judging team. Judging teams and animal and carcass evaluation contests have been a part of animal science undergraduate education for several decades offering students an opportunity to make real-life assessments and develop a variety of critical career skills including communication, critical thinking, and industry knowledge (Heleski et al., 2003). The animal welfare judging teams are still nascent compared to traditional livestock judging but participation in the annual intercollegiate AVMA Animal Welfare Assessment Contest has continued to increase (personal communication, L. N. Edwards-Callaway). Research has demonstrated that animal welfare judging teams are a beneficial experiential learning activity that significantly increase veterinary students' engagement with animal welfare topics in professional decision making and career choices after students participate in an animal welfare judging competition (Johnson et al., 2020). Perceptions and attitudes of undergraduate and graduate students who have participated in the contest have not been explored. The development of opportunities like animal welfare judging could provide undergraduate and graduate students with hands-on learning that not only increases animal welfare competencies, but also provides valuable skills important for professional development.

The majority of survey respondents strongly agreed that animal welfare courses would be helpful to their future careers. This is supported by the fact that many survey respondents indicated they wanted to pursue careers in veterinary medicine or production animal management, both fields in which knowledge and application of animal welfare principles are essential. Knowledge about standard animal husbandry practices and animal welfare-related issues is currently lacking among animal science students (Heleski and Zanella, 2006), though this population should have an increased knowledge base about these issues. Heleski and Zanella (2006) showed awareness of modern animal agriculture practices was low among university animal science



students, with more than 50% of students stating they would be uncomfortable with or would not use products from industry-typical egg operations, dairy operations, pig facilities, and horse training facilities when presented with hypothetical scenarios. This lack of knowledge could play a role in how students perceive and assess animal welfare challenges as they move into different careers in addition to how they engage in the classroom. A previous study demonstrated several benefits to veterinary students who took an animal welfare course, including improved confidence in conducting research on animal welfare topics and more favorable views on the inclusion of an animal welfare course in the veterinary curriculum (Johnstone et al., 2019). Future studies could investigate the benefits to animal science students who take an animal welfare course and how they integrate the concepts learned into their future careers.

As literature regarding animal science student perceptions of animal welfare remains limited, suggestions for future research include investigating how student perceptions change before and after animal welfare education, how animal welfare topics are integrated into other courses, effective teaching strategies for animal welfare courses, and how participation in welfare judging teams impacts perceptions and understanding of animal welfare. The results of this survey suggest that students within animal science departments both appreciate the relevance of animal welfare to their educational experience and expect that welfare be an integral component of their animal science program. As animal welfare is a dynamic and evolving concept, so too should be the methods by which welfare topics are integrated into both classroom and extra-curricular learning. Assessing the effectiveness of different modes of delivery (e.g., online modules, discussion boards, direct observation, and assessment) utilized to teach animal welfare topics to undergraduate and graduate students is critical to the growth of animal welfare education in colleges and universities across the United States.

### SUPPLEMENTARY DATA

Supplementary data are available at *Translational Animal Science* online.

*Conflict of interest statement:* The authors declare no conflict of interest.

### LITERATURE CITED

- Abood, S. K., and J. M. Siegford. 2012. Student perceptions of an animal-welfare and ethics course taught early in the veterinary curriculum. *J. Vet. Med. Educ.* 39(2):136–141. doi:10.3138/jvme.0911.093R1
- American Association of Veterinary Medical Colleges (AAVMC). 2018. Competency based veterinary education: CBVE framework. Available from [aavmc.org/wp-content/uploads/2020/10/CBVE-Publication-1-Framework.pdf](http://aavmc.org/wp-content/uploads/2020/10/CBVE-Publication-1-Framework.pdf) [accessed October 6, 2021].
- American College of Animal Welfare (ACAW). 2021. About the American College of Animal Welfare. Available from <https://www.acaw.org> [accessed December 10 2021].
- American Veterinary Medical Association (AVMA). 2020. Women practice owners projected to overtake men within a decade. Available from <https://www.avma.org/javma-news/2020-12-15/women-practice-owners-projected-overtake-men-within-decade> [accessed November 21 2021].
- Broom, D. M. 2005. Animal welfare education: development and prospects. *J. Vet. Med. Educ.* 32(4):438–441. doi:10.3138/jvme.32.4.438
- Broom, D. M. 2010. Animal welfare: an aspect of care, sustainability, and food quality required by the public. *J. Vet. Med. Educ.* 37(1):83–88. doi:10.3138/jvme.37.1.83
- Carter, T. J., and D. Dunning. 2008. Faculty self-assessment: why evaluating one's own competence is an intrinsically difficult task. *Soc. Personal. Psychol. Compass.* 2(1):346–360. doi:10.1111/j.1751-9004.2007.00031.x
- Colonus, T., and J. Swoboda. 2010. Student perspectives on animal-welfare education in American veterinary medical curricula. *J. Vet. Med. Educ.* 37(1):56–60. doi:10.3138/jvme.37.1.56
- Croft, G. K. 2019. The U.S. Land-Grant University system: an overview. congressional research service. Available from [https://www.everycrsreport.com/files/20190829\\_R45897\\_5efa0858fffb8907390aa992527916fdb88aa8d54.pdf](https://www.everycrsreport.com/files/20190829_R45897_5efa0858fffb8907390aa992527916fdb88aa8d54.pdf) [accessed November 22, 2021].
- Deslauriers, L., L. S. McCarty, K. Miller, K. Callaghan, and G. Kestin. 2019. Measuring actual learning versus feeling of learning in response to being actively engaged in the classroom. *Proc. Natl. Acad. Sci. U. S. A.* 116(39):19251–19257. doi:10.1073/pnas.1821936116
- Federation of Veterinarians of Europe (FVE). 2019. European veterinary education in animal welfare: day-1 competences. Available from <https://fve.org/publications/european-veterinary-education-in-animal-welfare-day-1-competences-full-report/> [accessed November 16, 2021].
- Fraser, D. 2008. Assessing animal welfare at the farm and group level: the interplay of science and values. *Anim. Welf.* 12(4):433–443.
- Freeman, S., S. L. Eddy, M. McDonough, M. K. Smith, N. Okoroafor, H. Jordt, and M. P. Wenderoth. 2014. Active learning increases student performance in science, engineering, and mathematics. *Proc. Natl. Acad. Sci. U. S. A.* 111(23):8410–8415. doi:10.1073/pnas.1319030111
- Freire, R., C. J. C. Phillips, J. M. Verrinder, T. Collins, C. Degeling, A. Fawcett, A. D. Fisher, S. Hazel, J. Hood, J. Johnson, et al. 2017. The importance of animal welfare science and ethics to veterinary students in Australia and New Zealand. *J. Vet. Med. Educ.* 44(2):208–216. doi:10.3138/jvme.1215-191R
- Friend, T. H. 1990. Teaching animal welfare in the land grant universities. *J. Anim. Sci.* 68(10):3462–3467. doi:10.2527/1990.68103462x
- Hazel, S. J., T. D. Signal, and N. Taylor. 2011. Can teaching veterinary and animal-science students about animal welfare affect their attitude toward animals and human-related empathy? *J. Vet. Med. Educ.* 38(1):74–83. doi:10.3138/jvme.38.1.74



- Heleski, C. R., A. J. Zanella, and E. A. Pajor. 2003. Animal welfare judging teams—a way to interface welfare science with traditional animal science curricula? *Appl. Anim. Behav. Sci.* 81(3):279–289. doi:[10.1016/S0168-1591\(02\)00287-3](https://doi.org/10.1016/S0168-1591(02)00287-3)
- Heleski, C. R., and A. J. Zanella. 2006. Animal science student attitudes to farm animal welfare. *Anthrozoös.* 19(1):3–16. doi:[10.2752/089279306785593883](https://doi.org/10.2752/089279306785593883)
- Hewson, C. J. 2003. What is animal welfare? Common definitions and their practical consequences. *Can. Vet. J.* 44(6):496–499.
- Isenberg, G. A., V. Roy, J. Veloski, K. Berg, and C. J. Yeo. 2015. Evaluation of the validity of medical students' self-assessments of proficiency in clinical simulations. *J. Surg. Res.* 193(2):554–559. doi:[10.1016/j.jss.2014.09.036](https://doi.org/10.1016/j.jss.2014.09.036)
- Johnson, C. L., L. J. McKinney, and E. G. Patterson-Kane. 2020. Effects of participating in the annual Animal Welfare Assessment Contest on veterinary students' self-perceived knowledge of and attitudes toward animal welfare science and their career choices. *J. Am. Vet. Med. Assoc.* 256(2):239–244. doi:[10.2460/javma.256.2.239](https://doi.org/10.2460/javma.256.2.239)
- Johnstone, E. C. S., M. A. Frye, L. K. Lord, A. K. Baysinger, and L. N. Edwards-Callaway. 2019. Knowledge and opinions of third year veterinary students relevant to animal welfare before and after implementation of a core welfare course. *Front. Vet. Sci.* 10(6):103. doi:[10.3389/fvets.2019.00103](https://doi.org/10.3389/fvets.2019.00103)
- Lofstedt, J. 2003. Gender and veterinary medicine. *Can. Vet. J.* 44(7):533–535.
- Lord, L. K., S. T. Millman, L. Carbone, N. Cook, A. Fisher, D. McKeegan, et al. 2017. A model curriculum for the study of animal welfare in colleges and schools of veterinary medicine. *J. Am. Vet. Med. Assoc.* 250(6):632–640. Doi:[10.2460/javma.250.6.632](https://doi.org/10.2460/javma.250.6.632)
- Lord, L. K., and J. B. Walker. 2009. An approach to teaching animal welfare issues at The Ohio State University. *J. Vet. Med. Educ.* 36(3):276–279. doi:[10.3138/jvme.36.3.276](https://doi.org/10.3138/jvme.36.3.276)
- Lord, L. K., J. B. Walker, C. C. Croney, and G. C. Golab. 2010. A comparison of veterinary students enrolled and not enrolled in an animal-welfare course. *J. Vet. Med. Educ.* 37(1):40–48. doi:[10.3138/jvme.37.1.40](https://doi.org/10.3138/jvme.37.1.40)
- Lund, V., G. Coleman, S. Gunnarsson, M. C. Appleby, and K. Karkine. 2006. Animal welfare science—working at the interface between the natural and social sciences. *Appl. Anim. Behav. Sci.* 97(1):37–49. doi:[10.1016/j.applanim.2005.11.017](https://doi.org/10.1016/j.applanim.2005.11.017)
- MacKay, J. R., F. Langford, and N. Waran. 2016. Massive open online courses as a tool for global animal welfare education. *J. Vet. Med. Educ.* 43(3):287–301. doi:[10.3138/jvme.0415-054R2](https://doi.org/10.3138/jvme.0415-054R2)
- Mota-Rojas, D., A. Orihuela, A. Strappini-Asteggiano, M. Nelly Cajiao-Pachón, E. Agüera-Buendía, P. Mora-Medina, M. Ghezzi, and M. Alonso-Spilsbury. 2018. Teaching animal welfare in veterinary schools in Latin America. *Int. J. Vet. Sci. Med.* 6(2):131–140. Doi:[10.1016/j.ijvsm.2018.07.003](https://doi.org/10.1016/j.ijvsm.2018.07.003)
- National Center for Education Statistics (NCES). 2019. Available from <https://nces.ed.gov/collegenavigator/> [accessed October 6, 2021].
- National Institute of Food and Agriculture (NIFA). 2021. Land grant colleges and universities. Available from <https://nifa.usda.gov/land-grant-colleges-and-universities> [accessed October 6, 2021].
- O'Malley, C.I. and J. M. Siegford. 2018. Student learning in animal welfare assessment: coursework vs. coursework and a judging competition. *NACTA. J.* 63:307.
- Parrish, J. J., M. F. Smith, R. D. Geisert, D. L. Davis, M. E. Wilson, and W. L. Flowers. 2015. How to communicate with undergraduate students that lack an animal science or agricultural background. *Anim. Front.* 5(3):54–59. Doi:[10.2527/af.2015-0035](https://doi.org/10.2527/af.2015-0035)
- Proudfoot, K. L., and B. A. Ventura. 2021. Impact of a frame reflection assignment on veterinary student perspectives toward animal welfare and differing viewpoints. *J. Vet. Med. Educ.* 48(3):361–372. doi:[10.3138/jvme.2019-0123](https://doi.org/10.3138/jvme.2019-0123)
- Shepherd, A. J., and L. Pikel. 2012. Employment of female and male graduates of US veterinary medical colleges. *J. Am. Vet. Med. Assoc.* 243:1122–1126. doi:[10.2460/javma.241.8.1040](https://doi.org/10.2460/javma.241.8.1040)
- Shivley, C. B., F. B. Garry, L. R. Kogan, and T. Grandin. 2016. Survey of animal welfare, animal behavior, and animal ethics courses in the curricula of AVMA Council on Education-accredited veterinary colleges and schools. *J. Am. Vet. Med. Assoc.* 248(10):1165–1170. doi:[10.2460/javma.248.10.1165](https://doi.org/10.2460/javma.248.10.1165)
- Siegford, J. M., T. M. Bernardo, R. P. Malinowski, K. Laughlin, and A. J. Zanella. 2005. Integrating animal welfare into veterinary education: using an online, interactive course. *J. Vet. Med. Educ.* 32(4):497–504. doi:[10.3138/jvme.32.4.497](https://doi.org/10.3138/jvme.32.4.497)
- Siegford, J. M., S. Y. Cottee, and T. M. Widowski. 2010. Opportunities for learning about animal welfare from online courses to graduate degrees. *J. Vet. Med. Educ.* 37(1):49–55. doi:[10.3138/jvme.37.1.49](https://doi.org/10.3138/jvme.37.1.49)
- Sisson, D. C. 2017. Control mutuality, social media, and organization-public relationships: a study of local animal welfare organizations' donors. *Public. Relat. Rev.* 43(1):179–189. Doi:[10.1016/j.pubrev.2016.10.007](https://doi.org/10.1016/j.pubrev.2016.10.007)
- U.S. News and World Report. 2021. Colleges offering an animal science major. Available from <https://www.usnews.com/best-colleges/animal-science-major-0109> [accessed October 6, 2021].
- Vargas-Bello-Pérez, E., C. Obermöller-Bustamante, I. Faber, T. Tadich, and P. Toro-Mujica. 2021. Knowledge and perception on animal welfare in Chilean undergraduate students with emphasis on dairy cattle. *Animals.* 11(7):1921. Doi:[10.3390/ani11071921](https://doi.org/10.3390/ani11071921)
- Verbeke, W. 2009. Stakeholder, citizen and consumer interest in farm animal welfare. *Anim. Welf.* 18(4):325–333.
- Wise, J. K., and M. L. Gonzalez. 2002. Employment of male and female graduates of US veterinary medical colleges, 2001. *J. Am. Vet. Med. Assoc.* 220:600–602. doi:[10.2460/javma.2002.220.600](https://doi.org/10.2460/javma.2002.220.600)
- World Veterinary Association (WVA). 2017. The role of veterinarians in animal welfare. Available from [https://www.worldvet.org/uploads/news/docs/the\\_role\\_of\\_vets\\_in\\_aw\\_-\\_leaflet.pdf](https://www.worldvet.org/uploads/news/docs/the_role_of_vets_in_aw_-_leaflet.pdf) [accessed November 16, 2021].