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Animal Health and Well Being

A preliminary exploration of the impact of experiential learning on animal science undergraduates' perceptions of humane stunning and slaughter

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ABSTRACT

It is essential to educate students about humane slaughter as it is a critical component of livestock production, particularly for animal science students who represent future stakeholders in agriculture. There is limited research about the effects of experiential learning on student comfort in participating in education regarding sensitive, yet important topics in the animal sciences. A survey was developed to investigate how a teaching module using an experiential learning activity to teach undergraduates about the slaughter process affected student perceptions of stunning and slaughter. Students enrolled in an animal science course, in which live animals and carcasses are evaluated, were surveyed before and after a teaching module. The module included a lecture about proper stunning and a laboratory activity in which the students had the opportunity to shoot a captive bolt stunner on both model and carcass heads. Respondents completed a pre-survey, attended the laboratory activity, and completed a post-survey; 29 survey responses were recorded. Most respondents were women (23, 79.3%) between the ages of 18 and 21 years (25, 86.2%) and in their first year of college (11, 37.9%). The majority of respondents (22, 75.9%) reported using the captive bolt stunner to stun the model heads during the laboratory activity. After participating in the module, all students strongly agreed that "stunning" is a critical component of livestock slaughter (29, 100%) and most agreed that "stunning is a humane process that ensures animal welfare during the slaughter process" (25, 86.2%). The majority of respondents strongly agreed that the "humane stunning simulation was beneficial to their learning about livestock slaughter" (21, 72.4%) and "improved their understanding of slaughter" (16, 55.2%). Almost all of the survey respondents either agreed or strongly agreed that "the model heads and captive bolt demonstration made them more comfortable with the slaughter process" (14, 48.3%; 14, 48.3%, respectively). This research suggests that experiential learning opportunities are potentially effective teaching strategies for educating undergraduates about the slaughter process. Future research should focus on practical ways to integrate new teaching methods into existing animal science curricula, as this will be critical for educating students on important topics in livestock production and increasing student comfort with sensitive material.

Key words: animal science, education, experiential learning, slaughter, stunning, undergraduate

INTRODUCTION

In the United States, approximately 165.6 million livestock are slaughtered annually for food production in federally inspected slaughter plants (USDA ERS, 2022). Although more than 95% of the U.S. population consumes animal-derived proteins, less than an estimated 0.16% of people in the United States are directly involved with the production and slaughter of animal-derived proteins (NAMI, 2017; Reinhart, 2018). This degree of separation from how food is produced can lead to misconceptions about the treatment animals receive both on farms and at slaughter facilities; a consumer survey conducted by the Center for Food Integrity indicated that only 25% of consumers believed their meat was humanely produced (Center for Food Integrity, 2017). The slaughter industry faces a unique challenge: the concept of taking an animal's life seems counterintuitive to upholding animal welfare, yet federal regulations (HMSA, 1978), global and national guidelines (Leary, 2016; OIE, 2016; NAMI, 2021), and company-specific programs (e.g., Cargill, 2022) ensure that welfare of livestock is maintained during this critical component of meat production (Edwards-Callaway and Calvo-Lorenzo, 2020).

Barring exemptions for religious slaughter, federal regulations require that livestock slaughtered at United States Department of Agriculture Food Safety Inspection Services inspected facilities are stunned prior to further processing as required by Humane Methods of Slaughter Act (HMSA, 1978; CFR, 1979). Stunning causes instantaneous loss of sensibility and consciousness, preventing the animal from experiencing pain or stress from subsequent processing steps including exsanguination and is, therefore, an integral component of ensuring animal welfare at slaughter. If this step is not performed correctly, the animal could return to sensibility, resulting in compromised animal welfare and a regulatory non-compliance. Nonetheless, a challenge persists for those whose jobs involve ending an animal's life (i.e., slaughter plant employees, veterinarians) since opportunities to observe and practice humane stunning are limited. In industry settings, more training opportunities exist for slaughter

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plant employees to practice humane stunning (via in-person, in-house trainers, and "on-the-job" training) than in classroom settings, where opportunities to practice stunning techniques in a manner that safeguards both human safety and animal welfare are lacking. Exposing animal science students to topics critical to meat production is vital as they will need to apply the skills developed in their coursework to their future careers in agriculture and effectively communicate these practices to consumers.

Outside of some of the challenges mentioned with providing training opportunities and doing so in a way that does not compromise animal welfare, end-of-life decisions, including slaughter and euthanasia, are traditionally sensitive and difficult subjects to teach and discuss (Anderson et al., 2013; Scotney et al., 2015; Hulsbergen et al., 2019; Román-Muñiz et al., 2021). There is very limited research exploring best practices to teach students about the slaughter process and its impacts on animal welfare experiences (Seguino et al., 2014; Hulsbergen et al., 2019). While still limited, there is more information regarding teaching about euthanasia-related topics in the field of veterinary medicine (Seguino et al., 2014; Hulsbergen et al., 2019), but this is also limited. Two studies, however, have explored methods of teaching about the slaughter process using novel training techniques, and their subsequent effects on veterinary students' emotions and learning experiences (Seguino et al., 2014; Hulsbergen et al., 2019). Hulsbergen et al. (2019) reported that veterinary students experience challenging emotions when learning about and practicing humane slaughter; in their study, adding a video of stunning and a period of self-reflection to existing coursework did not mitigate negative emotions associated with the learning experience. In another study, veterinary students reported that a virtual slaughterhouse simulation was a useful teaching tool for humane slaughter and that the interactive experience was beneficial to their learning about the slaughter process (Seguino et al., 2014). While these studies begin to address a critical gap in knowledge, further research into how to best educate and train students about important topics in livestock production will be crucial for upholding animal welfare and human safety in the future. At the same time, students need to feel comfortable learning about such topics in order to engage fully in their learning experience. Innovative teaching strategies, such as the slaughter simulator employed by Seguino et al. (2014), may be a promising tool to familiarize students with "real-life" situations and circumstances regarding slaughter before stunning an animal in vivo.

A multitude of work has established that teaching strategies that facilitate active learning, (i.e., engaging in "hands-on" activities, discussions, writing, and presenting), are effective methods for increasing students' understanding of the subject matter (Zhang et al., 2020; Ruiz-Romero and Vargas-Bello-Pérez, 2022). Additionally, students who participate in active learning tend to perform higher on standardized exams than those who participate in passive learning (Freeman et al., 2014; Deslauriers et al., 2019). More recently, educators in higher education have recognized the value of experiential learning (a form of active learning), which was first described by Kolb (1984), and emphasizes the role that student experiences play in creating knowledge. During experiential learning activities, students are challenged to engage both directly (e.g., experiencing and experimenting) and indirectly (e.g., observing and conceptualizing) with new experiences against the backdrop of their previous experiences (Kolb, 1984). Due to the nature of experiential learning, there is also substantial discussion in this area about the benefits and importance of student-centered (as opposed to teacher-centered) learning opportunities in which the student drives the learning process and the teacher facilitates the experience (Estes, 2004; Mascolo, 2009; Overby, 2011; Grover and Stovall, 2013). A variety of disciplines in higher education, including in the animal and veterinary sciences, have integrated experiential learning activities into existing curricula and have demonstrated student-oriented benefits such as improved critical thinking and problem-solving skills (Reiling et al., 2003; Seguino et al., 2014; Ruiz-Romero and Vargas-Bello-Pérez, 2022). Despite the identified benefits associated with experiential learning, most courses at the collegiate level are still taught with traditional lecture-based methods (Wurdinger and Allison, 2017; Ferree et al., 2022).

There is a lack of research exploring the use of experiential learning activities to teach students about animal welfare during humane slaughter and how these learning activities impact students' perceptions about welfare during slaughter. The objective of the current study was to investigate how using an experiential learning activity, facilitated by several teaching techniques, to teach animal science undergraduates about the slaughter process affected student perceptions and attitudes toward animal stunning and slaughter.

MATERIALS AND METHODS

The Colorado State University (CSU) Institutional Review Board approved the study materials and research plan prior to study recruitment and survey initiation (#3114).

Study Population and Recruitment

The target population for this study was undergraduate students enrolled in Animal and Equine Sciences Live Animal and Carcass Evaluation (ANEQ 250), an elective, second-year course for Animal and Equine Science majors enrolled in the Department of Animal Sciences within the College of Agricultural Sciences at CSU. During the 2022 spring semester, ANEQ 250 students participated in a week-long teaching module about livestock slaughter. The course has a capacity of 65 students and 62 students were enrolled during the study semester. The module included a 30-min lecture on Wednesday about proper stunning and its implications for animal welfare and human safety, a 90-min laboratory session on Friday involving the use of model heads (i.e., a three-dimensional realistic representation of a cow head with reusable silicone brain canisters for captive bolt penetration), and pig and cow carcass heads to teach about the stunning process. The lecture material covered topics related to animal welfare at slaughter, such as best handling practices and regulatory requirements, and different stunning methods, including captive bolt stunning in addition to other methods. Students were asked to fill out a consent form and complete a pre-survey prior to the lecture portion of the module; a researcher with no role in the course obtained informed consent from students. Respondents were not offered any incentive for their participation in the study; involvement was voluntary, and respondents could withdraw their consent at any time. All students enrolled in ANEQ 250, regardless of participation in the study, were expected to attend the stunning and slaughter laboratory activity. Attendance was taken on

the day of the laboratory activity but no points were awarded to students for their participation.

At the beginning of the laboratory session, the instructor reviewed operating instructions and safety precautions, and provided students with personal protective equipment (earplugs, safety glasses, and a protective vest while operating the captive bolt stunner). During the laboratory session, students rotated in groups of approximately 15 students through three 20-min stations: 1) students had the opportunity to practice a humane stunning simulation with a handheld captive bolt stunner (PAS Type C.25, Jarvis Products Corp., Middletown, CT) on a cow model head (Veterinary Simulator Industries, Calgary, Alberta, Canada), 2) students were able to practice stunning with the same model captive bolt stunner on a pig carcass head (electrically stunned so there was no bolt hole in the head), and 3) students observed a demonstration with split cow and pig carcass heads to observe brain location within the skull and correct stunner placement. In class the following Monday, a post-survey was distributed to respondents to assess how the module impacted their learning and perceptions.

Respondents were asked to write their names on each survey for the purposes of matching both pre- and post-surveys. After completion of the pre-survey, a researcher with no role in the course uploaded the names of respondents into a Microsoft Excel (Microsoft Corporation, Redmond, WA) spreadsheet and assigned each respondent a unique identifier. After the completion of both surveys, the same investigator used the spreadsheet to write the unique identifier of each respondent on both of their pre- and post-surveys. At this time, all identifying information, including names, was removed from the surveys with only the unique identifier remaining.

Survey Development and Content

The surveys were developed by an interdisciplinary team of investigators with expertise in slaughter, animal welfare, social science, meat science, and teaching research. The pre-survey consisted of 14 questions, including seven stunning-related Likert scale questions and seven demographic-related questions. The post-survey consisted of 17 questions, including the same set of 7 stunning-related Likert scale questions from the pre-survey, 8 additional Likert scale questions, and 2 free-response questions relating to the laboratory activity. The surveys took approximately 10 min to complete, and respondents were given class time to do so. The definition of stunning was provided in both surveys (i.e., rendering an animal unconscious (insensible) prior to processing so that the animal does not feel pain or discomfort). Both surveys are available in Supplementary Material.

Statistical Analysis

After both the pre-surveys and post-surveys were completed, all data were entered into Microsoft Excel (Microsoft Corporation, Redmond, WA). Pre- and post-surveys that could not be matched and surveys from students that did not attend the lecture or laboratory session were not considered in the statistical analysis. Summary statistics were calculated in Excel for all questions of interest. Unless otherwise stated, the following results are reported as (*n*, %).

Thematic analysis was conducted for the 3 free-response questions using a modified Braun and Clarke (2006) approach for a small data set. One researcher with experience performing thematic analysis reviewed all responses and identified the themes present. Due to the small sample size and uncomplicated nature of the responses, the same researcher coded each response using one of the identified themes.

RESULTS AND DISCUSSION

This survey aimed to investigate how using an experiential learning activity (i.e., using model cow and pig and cow carcass heads) to teach animal science undergraduates about the slaughter process affected student perceptions of and attitudes toward stunning and slaughter. Slaughter is a critical component of food animal production systems with implications for animal welfare and human safety (Edwards-Callaway and Calvo-Lorenzo, 2020) and thus it is essential to educate and train students about proper humane stunning techniques. However, learning about the slaughter process can be a challenging experience for students; Hulsbergen et al. (2019) reported that teaching humane slaughter techniques to a group of Dutch veterinary students resulted in significant mental challenges for the students, eliciting emotions of tenseness and insecurity with the process. Taken together, a challenge persists: how can instructors educate their students about challenging topics while fostering a classroom environment that encourages active engagement, participative learning, and comfort with the course content? While several studies have assessed the role of experiential learning activities on student-oriented benefits, including motivation, learning, and engagement (Reiling et al., 2003; Chavan, 2011; Seguino et al., 2014; Coker and Porter, 2016; Kong, 2021), there is limited research regarding student perceptions of different teaching methods and the efficacy of experiential learning activities on student learning, particularly in the animal sciences. Moreover, limited research exists assessing the effectiveness of experiential learning to increase student interest and comfort in participating in education regarding sensitive yet important topics such as stunning and euthanasia.

To be included in final analysis, respondents needed to have filled out a pre-survey, attended the lecture, attended the laboratory activity, and filled out a post-survey. Thus, out of the 62 registered students in the class, 29 respondents were included in final analysis, resulting in a response rate of 46.8%. Although we were able to capture perceptions of approximately half of the class population, the sample size is somewhat limited and was directly impacted by student attendance (e.g., failure of students to be present for all study components). Due to time constraints and other class logistics, the consent procedures/pre-survey/lecture portion, laboratory activity, and post-survey occurred on three separate days, and students had to be present for all three occasions. In future iterations of this work, the authors plan to have the laboratory session and post-survey in the same class period to maximize the number of students present for all three components of the module. One study assessing faculty perceptions and use of experiential learning in higher education found that class structure, large class sizes, attendance, time constraints, and faculty resistance were just some of the major obstacles to implementing experiential learning activities (Wurdinger and Allison, 2017), some of which were experienced in the current study. This study provides useful preliminary data to be used in future studies focusing on the application of experiential learning within animal science degree programs.

The survey population was generally representative of published enrollment trends at CSU for past undergraduate

classes in the College of Agricultural Sciences (CSU, 2022). The majority of respondents identified as white (23, 79.3%), and a woman (23, 79.3%) and the ages of students ranged from 18 to 21 years and older, 19 years of age (10, 34.5%) and being in their first year of college (11, 37.9%) were the most common (Table 1). The greatest proportion of respondents were from the West region (i.e., CA, CO, ID, MT, NV, OR, UT, WA, WY; 13, 44.8%) and suburban (14, 48.3%) backgrounds. A 2021 CSU student factsheet (CSU, 2022) indicated that the college was primarily white (75%) and female (71%), similar to the demographics of our survey respondents. While enrollment trends for undergraduate students in animal science departments are not widely published, the study population is also consistent with Parrish et al. (2015), who reported undergraduates in animal science departments of a subset of institutions were 75% to 80% female. In our survey, 86.2% (25) of respondents were aged 18 to 21 years of age, slightly younger than the 74.5% of college students nationwide aged 18 to 24 years of age (NCES, 2019).

Most of our survey respondents were either from rural or suburban backgrounds, with a smaller percentage of respondents from urban backgrounds (Table 1); this differs from previous studies that have found that most animal science undergraduates come from urban backgrounds, otherwise regarded as non-agricultural backgrounds (Reiling et al., 2003; Parrish et al., 2015). One possible reason for this disparity could be that student backgrounds are often defined differently across studies, for example, one of the aforementioned studies defines background as a percentage of family income associated with production agriculture (i.e., from a farm/ranch; not from a farm or ranch; Parrish et al., 2015) while the other uses a combination of population size, acreage size, and percentage of family income associated with production agriculture to define backgrounds (i.e., small-town; urban; raised on acreage; from an extensive rural farm/ranch; Reiling et al., 2003). This survey did not define the terms urban, suburban, or rural for survey respondents; the terms were open to interpretation and could have contributed to the higher than anticipated number of students from rural and suburban backgrounds (11, 37.9%; 14, 48.3%, respectively).

In the current study, five (17.2%) respondents had no prior exposure to stunning or the slaughter process, 11 (37.9%) respondents understood the process but had never watched it, 9 (31.0%) had previously witnessed the slaughter process, and 4 (13.8%) had previously performed stunning and/or slaughter (Table 1). The high percentage of respondents who had previously witnessed slaughter or had performed slaughter was unexpected and may be unique to this study population. This is of particular note due to the large proportion of students in this study that came from urban or suburban backgrounds, population areas that one may consider as having limited opportunities to witness slaughter activities. One potential explanation for this could be that the terms "witnessing" or "performing" slaughter were not defined for survey respondents; the terms were self-defined and could have contributed to the greater than expected number of students who were familiar with or had previously performed stunning or slaughter. Furthermore, students rely on social media as a primary source of information when researching animal welfare topics (Mijares et al., 2021; Vargas-Bello-Pérez et al., 2021), and thus the considerable number of students who had previously witnessed slaughter might be explained by prior exposure to videos on social media platforms and not due to in-person experiences. Additionally, the term "slaughter" was not defined in the survey, therefore, respondents may have considered other experiences, such as hunting or butchering,

Table 1. Summary of survey respondent demographics (n = 29)

Demographic	n, %
Gender	
Man	5, 17.2%
Woman	23, 79.3%
Non-binary	0, 0%
Other	0, 0%
Prefer not to answer	1, 3.4%
Race and Ethnicity	
White	23, 79.3%
American Indian or Alaska Native	2, 6.9%
Native Hawaiian or Other Pacific Islander	0, 0%
Hispanic or Latino (of any race)	2, 6.9%
Hispanic or Latino/White	2, 6.9%
Other	0, 0%
Prefer not to answer	0, 0%
Age	
18	5, 17.2%
19	10, 34.5%
20	6, 20.7%
21	4, 13.8%
>21	4, 13.8%
Region[1]	
Midwest	5, 17.2%
Northeast	2, 6.9%
Southeast	2, 6.9%
Southwest	6, 20.7%
West	13, 44.8%
Alaska or Hawaii	1, 3.4%
Hometown	
Rural	11, 37.9%
Suburban	14, 48.3%
Urban	3, 10.3%
Other	1, 3.4%
Level of exposure	
None	5, 17.2%
Understood the process but had never watched it	11, 37.9%
Previously witnessed the slaughter process	9, 31.0%
Have performed stunning/slaughter	4, 13.8%
Class level	
Freshman	11, 37.9%
Sophomore	8, 27.6%
Junior	7, 24.1%
Senior	3, 10.3%

[1]The Midwest region included Iowa, Illinois, Indiana, Kansas, Michigan, Minnesota, Mississippi, North Dakota, Nebraska, Ohio, South Dakota, and Wisconsin. The Northeast region included Connecticut, Delaware, Massachusetts, Maine, Maryland, New Hampshire, New Jersey, New York, Pennsylvania, Vermont, and Rhode Island. The Southeast region included Alabama, Arkansas, Florida, Georgia, Louisiana, Kentucky, Mississippi, North Carolina, South Carolina, Tennessee, Virginia, and West Virginia. The Southwest region included Arizona, New Mexico, Oklahoma, and Texas. The West region included California, Colorado, Idaho, Montana, Nevada, Oregon, Utah, Washington, and Wyoming.

as a form of slaughter, rather than the conventional processing plant method as was intended in the survey. This likely could have contributed to the greater than anticipated number of students who identified as previously performing slaughter.

In the study, the perceptions of stunning were generally very positive, as seen across all of the survey questions. In the pre-survey, all respondents either agreed (3, 10.3%) or strongly agreed (26, 89.7%) with the statement "stunning is a critical component of livestock slaughter," while all respondents in the post-survey strongly agreed with that statement (29, 100%; Table 2). In response to the statement "stunning is a humane process that ensures animal welfare during the slaughter process," all respondents (29, 100%) either agreed or strongly agreed with the statement in both the pre- and post-surveys with a slight increase in the number of strongly agree responses in the post-survey (25, 86.2%) compared to the pre-survey (19, 65.5%). Similar increases in strongly agree responses were observed with the statement "human safety is an important part of training an individual to use stunning equipment," where all respondents (29, 100%) agreed or strongly agreed, but strongly agreed responses increased from 26 (89.7%) in the pre-survey to 28 (96.6%) in the post-survey.

Of the 29 respondents, 22 (75.9%) indicated that they tried using the captive bolt stunner on the model head during lab. A follow-up question was asked "why or why not," and responses are summarized in Table 3. Two themes, "experience and knowledge" and "important concept" were identified in responses to answering why a respondent participated in the activity. Some examples of responses within these two themes, respectively, included: "*I try not to turn down experiences where I can learn something new*" and "*important to understand how animals are stunned*." Students surveyed indicated that the laboratory activity made them more comfortable with the slaughter process. This is of particular note since slaughter is a traditionally sensitive and challenging subject to learn. In response to the statement "discussing livestock slaughter makes me feel uncomfortable," most respondents either disagreed (16, 55.2%) or strongly disagreed (4, 13.8%) in the pre-survey, and disagreement increased in the post-survey with 21 respondents (72.4%) disagreeing and 6 respondents (20.7%) strongly disagreeing (Table 2). In the pre-survey, many respondents disagreed (16, 55.2%) or strongly disagreed (4, 13.7%) with the statement "watching livestock slaughter makes me feel uncomfortable," and the post-survey showed slight increases in disagree and strongly disagree responses (18, 62.1% and 6, 20.7%, respectively). Similar results were also seen with the statement "slaughter is a painful process for animals". In response to the statement "I feel prepared to discuss the slaughter process," a majority of respondents in the pre-survey agreed (17, 58.6%) or strongly agreed (10, 34.5%), while on the post-survey all respondents either agreed (19, 65.5%) or strongly agreed (10, 34.5%) with the statement (Table 2).

The perceptions and attitudes of the survey respondents regarding stunning and slaughter could be the result of prior exposure to these topics in other their animal science coursework, or that students who attended class and participated in the laboratory activity were already comfortable with the course content due to their background, past experiences, or other factors which were not controlled for in the study. Moreover, this course was an optional elective course, and students who were already comfortable with and aware of stunning and slaughter may have been more inclined to enroll in the course and participate in the activities, perhaps introducing bias into the sample, thus contributing to the higher-than-expected number of students who were comfortable with livestock slaughter before the module. Although the small sample size limits the conclusions that can be drawn from the results, significant student engagement with the activity and the largely positive feedback is evidence to suggest that utilizing an experiential learning activity (i.e., using model cow and carcass heads) could be an effective strategy for teaching about the slaughter process. Future iterations of this work should include questions aimed at understanding how student demographics, backgrounds, and prior experiences influence their perceptions of and attitudes toward critical topics in livestock production. Additionally, the survey did not include questions about asking why students enrolled in the class and what their future goals were; understanding why students chose to participate in the course could be helpful in explaining their perceptions.

Effective strategies for educating and training students about slaughter have not been extensively explored. Two studies, however, have assessed the effects of novel training techniques to teach about the slaughter process on veterinary student emotions, reporting that adding a video of stunning and a period of self-reflection to existing veterinary medicine coursework (Hulsbergen et al., 2019) or using a virtual slaughterhouse simulator (Seguino et al., 2014) as a novel educational experience did not result in significant differences in student emotions between the control groups and groups exposed to the interventions. However, students who participated in the virtual slaughterhouse simulation reported positive experiences overall, indicating that it was a valuable teaching aid, and that the interactive nature of the activity benefited their learning experience (Seguino et al., 2014). This research aligns with the present study's findings, in which survey respondents cited similar sentiments. One student even indicated that *"being able to try [the captive bolt simulation] in a safe and comfortable environment"* was one of the most valuable aspects of the laboratory activity. Several studies have highlighted that simulations (i.e., virtual learning experiences that simulate "real-life" situations or environments) are potentially effective modes of teaching students and are particularly useful for familiarizing students with new experiences while fostering a connection between lecture material and real-world practice (Cleave-Hogg and Morgan, 2002; Seguino et al., 2014; Ruiz-Romero and Vargas-Bello-Pérez, 2022). Additionally, using simulations may increase student comfort with livestock slaughter and warrants further research into ways to engage students more fully in educational experiences. Traditionally in this course (ANEQ 250), the importance and process of stunning is described but there has been no hands-on experience for the students; the module discussed in this study was a novel approach to teaching in the context of this specific course.

Although many students participated in the stunning activity and responded positively to the module material, some students did not participate in the hands-on component of the activity (i.e., using the captive bolt stunner). The themes identified within responses of students who indicated they did not utilize the captive bolt stunner were "not comfortable" and "not a new experience." While the number of students who indicated discomfort with the experience was limited, it is essential that all students feel comfortable and safe in

Table 2. Summary of both pre- and post-survey responses to Likert questions related to perceptions about stunning and slaughter (n = 29)

Statement	Level of agreement	Pre-survey (n, %)	Post-survey (n, %)
Stunning is a critical component of livestock slaughter.	Strongly Disagree	0, 0%	0, 0%
	Disagree	0, 0%	0, 0%
	Agree	3, 10.3%	0, 0%
	Strongly Agree	26, 89.7%	29, 100%
	I do not know	0, 0%	0, 0%
Stunning is a humane process that ensures animal welfare during the slaughter process.	Strongly Disagree	0, 0%	0, 0%
	Disagree	0, 0%	0, 0%
	Agree	10, 34.5%	4, 13.7%
	Strongly Agree	19, 65.5%	25, 86.2%
	I do not know	0, 0%	0, 0%
Human safety is an important part of training an individual to use stunning equipment.	Strongly Disagree	0, 0%	0, 0%
	Disagree	0, 0%	0, 0%
	Agree	3, 10.3%	1, 3.4%
	Strongly Agree	26, 89.7%	28, 96.6%
	I do not know	0, 0%	0, 0%
Discussing livestock slaughter makes me feel uncomfortable.	Strongly Disagree	4, 13.8%	6, 20.7%
	Disagree	16, 55.2%	21, 72.4%
	Agree	6, 20.7%	2, 6.9%
	Strongly Agree	1, 3.4%	0, 0%
	I do not know	2, 6.9%	0, 0%
Watching livestock slaughter makes me feel uncomfortable.	Strongly Disagree	4, 13.7%	6, 20.7%
	Disagree	16, 55.2%	18, 62.1%
	Agree	6, 20.7%	3, 10.3%
	Strongly Agree	1, 3.4%	0, 0%
	I do not know	2, 6.9%	2, 6.9%
Slaughter is a painful process for animals.	Strongly Disagree	6, 20.7%	13, 44.8%
	Disagree	20, 69.0%	15, 51.7%
	Agree	1, 3.4%	1, 3.4%
	Strongly Agree	0, 0%	0, 0%
	I do not know	2, 6.9%	0, 0%
I feel prepared to discuss the slaughter process.	Strongly Disagree	0, 0%	0, 0%
	Disagree	1, 3.5%	0, 0%
	Agree	17, 58.6%	19, 65.5%
	Strongly Agree	10, 34.5%	10, 34.5%
	I do not know	1, 3.45%	0, 0%

classroom environments. Although the reason for discomfort was not asked, the use of a weapon, in this case a captive bolt stunner (or gun as referred to in the survey questions), is not something that everyone has familiarity with and thus could initiate some feelings of discomfort and uneasiness. Further investigation into student perceptions of different learning activities, particularly those surrounding more sensitive topics, will be critical for creating classroom environments that foster active engagement and participation from all students.

The post-survey included a section of statements to determine if there were benefits or improvements in student understanding and comfort of stunning and the slaughter process after participation in the laboratory activity. A summary of these responses is found in Table 4. The majority of respondents (21, 72.4%) strongly agreed that "watching the demonstration with the model heads and captive bolt gun was beneficial to my learning about livestock slaughter," and (23, 79.3%) strongly agreed that "watching the demonstration with the split carcass head specimens was beneficial to my learning about livestock slaughter." Almost all respondents either agreed (12, 41.4%) or strongly agreed (16, 55.2%) that "watching the demonstration with the model heads and the captive bolt gun improved my understanding of slaughter." Most respondents (23, 79.3%) strongly agreed that "watching the demonstration with the split carcass head specimens improved my understanding of slaughter." In terms of comfortability with the process, 14 (48.3%) respondents agreed and 14 (48.3%) strongly agreed that "watching the demonstration with the model heads and the captive bolt gun made me more comfortable with the slaughter process." Similar results were seen with the split carcass heads as 10 (34.5%) respondents agreed and 16 (55.2%) strongly agreed that "watching the demonstration with the split carcass head specimens made me more comfortable with the slaughter

Table 3. Summary of stunning activity participation (i.e., use of the captive bolt stunner) with examples from the subsequent question asking why or why not. One researcher coded all follow-up responses and the themes identified are indicated in the table (n = 28)

Question	Follow-up question: Why or why not?	
First question: Did you try using the captive bolt gun to stun the model head during lab? (n, %)	**Themes**	
	Experience and knowledge	**Important concept**
Yes (22, 75.9%)	*"to better understand the process and to be able to speak from experience"* *"I try to not turn down experiences where I can learn something new"* *"it was a new opportunity I was excited to try"* *"I wanted to try and I wanted to see what it was like for the handler"*	*"I feel I should understand the entire process that goes on in there [the meat lab]"* *"important to understand how animals are stunned"*
	Not comfortable	**Not a new experience**
No (6, 20.7%)	*"I didn't feel comfortable and knew I'd get the same learning experience either way"* *"I didn't feel comfortable using something like that"* *"I'm scared of guns and have no need to learn how to use a captive bolt"*	*"I didn't because I had already tried"*

Table 4. Summary of post-survey responses to Likert questions related to understanding and comfort with the topic after learning module implementation (n = 29)

Question	Strongly disagree	Disagree	Agree	Strongly agree	I do not know
Watching the demonstration with the model heads and captive bolt gun was beneficial to my learning about livestock slaughter.	0, 0%	1, 3.4%	7, 24.1%	21, 72.4%	0, 0%
Watching the demonstration with the split carcass head specimens was beneficial to my learning about livestock slaughter.	0, 0%	0, 0%	6, 20.7%	23, 79.3%	0, 0%
Watching the demonstration with the model heads and the captive bolt gun improved my understanding of slaughter.	0, 0%	1, 3.4%	12, 41.4%	16, 55.2%	0, 0%
Watching the demonstration with the split carcass head specimens improved my understanding of slaughter.	0, 0%	1, 3.4%	4, 13.8%	23, 79.3%	1, 3.4%
Watching the demonstration with the model heads and the captive bolt gun made me more comfortable with the slaughter process.	0, 0%	1, 3.4%	14, 48.3%	14, 48.3%	0, 0%
Watching the demonstration with the split carcass head specimens made me more comfortable with the slaughter process.	0, 0%	2, 6.9%	10, 34.5%	16, 55.2%	1, 3.4%
I would like to see hands-on activities similar to this integrated into other Animal Science courses.	0, 0%	0, 0%	8, 27.6%	21, 72.4%	0, 0%

process." All respondents either agreed (8, 27.6%) or strongly agreed (21, 72.4%) that they "*would like to see hands-on activities similar to this integrated into other Animal Science courses*."

Respondents were asked "what were the most valuable aspects" and "what were the least valuable aspects" about watching the model and carcass head demonstrations. Student responses indicated that the most valuable aspect of the demonstration was learning about brain anatomy and the relationship to stun location. Examples of responses include: "*I got to see what happened to the brain and why it is so important to have training,*" "*being able to see where the brain is and how big it is and how important it is to stun the correct area,*" and "*the model heads were really beneficial to see different stunning locations on different species*." Respondents indicated that the most valuable aspect of the laboratory activity was the hands-on nature of the learning experience: "*seeing how stunning is actually done gives me the opportunity to ask more questions and get hands on experience (how I learn)*" and "*being able to firsthand get an experience on how the whole process works and be able to learn from it*." The positive student response in the current study is supported by a multitude of studies that have reported that students perceive several benefits from participating in experiential learning activities (Reiling et al., 2003; Chavan, 2011; Seguino et al., 2014; Coker and Porter, 2016). The teaching module afforded students the opportunity to engage hands-on with the stunning simulation, familiarizing students with the stunning process in a safe and comfortable setting. Studies have shown that "learning by doing" is an effective teaching strategy with many learner-centered benefits, citing improved skill acquisition, knowledge retention, and problem-solving skills as

just some of the benefits of utilizing the pedagogical tool (Millenbah and Millspaugh, 2003; McLaughlin and Rogers, 2010). Kolb (1984) first defined experiential learning theory (ELT) as the method by which knowledge is formed through the transformation of experience. As its name and definition imply, ELT highlights the central role student experiences play in the learning process. New knowledge is created through the experiential learning cycle, comprised of four stages: concrete experience, reflective observation, abstract conceptualization, and active experimentation (Kolb, 1984). The activities implemented in the current study integrated all these stages into the entirety of the student experience; the module had both active and reflective components with opportunities to engage both directly (e.g., hands-on and observation) and indirectly (e.g., reflection of and synthesizing ideas).

Responses related to the "least valuable aspects" specifically indicated there were no aspects of the demonstration that were not helpful. However, a few individuals indicated the experience did not represent a realistic or beneficial simulation: *"might be the fake cattle head as it doesn't give me the full effect of what it would look like to stun cattle"* and *"after first person stunned pig head, it wasn't as helpful since there was already a hole and the brains started to emulsify after a few turns."* Some respondents indicated that they wanted more time and more experience with the exercise: *"I wish I had more time at each station! I really had fun!,"* and *"it would have been nice to be able to practice on cattle and swine heads."* To address these comments, it would be possible to procure different species carcass heads for the demonstration. Additionally, when this module is implemented in the future we can procure additional heads to better accommodate class size and participation and reduce skull damage to the heads being used.

In the almost four decades since ELT was first defined, many educators have considered the influential role of experiential learning on student performance (Freeman et al., 2014; Seguino et al., 2014, Deslauriers et al., 2019; Ferree et al., 2022), while also tailoring innovative teaching methods to fit a wide range of disciplines, student needs, and classroom environments (Reiling et al., 2003; Chavan, 2011; Coker and Porter, 2016). However, despite experiential learning's growing popularity among educators and students alike, the teaching method is not widely adopted in higher education programs and coursework. More passive forms of teaching and learning, including traditional lecturing (e.g., teachers presenting information and answering questions and students listening and taking notes), remain the most predominant teaching strategy employed in higher education (Wurdinger and Allison, 2017; Ferree et al., 2022). These findings warrant future work on ways to effectively overcome challenges associated with implementing innovative teaching methods into existing programs so that instructors can continue to develop and refine high-quality learner-centered coursework.

CONCLUSION

Assessing the effectiveness of different teaching techniques will be crucial for the education of important topics such as stunning, slaughter, and euthanasia, particularly for animal science students who will need to utilize knowledge from their coursework in future careers in animal-focused industries. While research regarding animal science student perceptions of different learning experiences remains limited, ample opportunities exist to assess the effectiveness of experiential learning on the student experience. Although preliminary, the results of this survey suggest that students appreciate hands-on activities in their animal science courses and that integrating experiential learning activities into the animal science curriculum benefits student perceptions of learning and increases student comfort with sensitive topics such as livestock slaughter. Overall, the student perceptions of stunning both related to its importance and their level of comfort with the topic were positive even before the module. The positive response to the laboratory activity warrants further investigation into student perceptions of and attitudes toward different teaching methods. Future research should explore practical ways to integrate new teaching strategies into existing animal science curricula to promote active, engaged learning through hands-on, applied activities.

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Conflict of interest statement

There are no known actual or potential conflicts of interest associated with this publication.

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