STUDENT-REPORTED EXPERIENCE OF USING VIRTUAL REALITY TO TOUR A LIVESTOCK FARM

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Abstract

Gaining adequate on-farm experience can be difficult for students due to limited resources, time, and strict biosecurity protocols. This study assessed university student perceptions of the usability of a virtual reality (VR) farm tour focused on swine or dairy farming. Seventy-one participants experienced a VR farm tour. After completing the tour, students were asked about their enjoyment and the usability of the VR farm experience. Students with prior VR experience found the tours to be more enjoyable (P = 0.01), felt the tour was a good supplement to a real farm visit (P = 0.01), and were more likely to gain new knowledge after undergoing the tour (P = 0.01) compared to students with only previous augmented realilty (AR) experience. Thematic analysis identified themes in student responses including recommendations for farm welfare improvements and the potential benefits of VR for various audiences. Fifty-one students could suggest an opportunity to improve farm welfare after completing a VR tour. Most users (43 responses) recommended VR tours for student use. Overall, previous experience with VR matters when considering implementation in the classroom. Additionally, students found the VR tours to be moderately useful in teaching animal welfare. Further research is needed to address technological issues and explore the implementation of VR in classrooms.

Keywords: virtual reality perceptions, attitudes, agriculture education, animal science

Animal Science Education

A majority of students enroll in undergraduate animal science programs with the goal of a future career in veterinary medicine (Ragland, 2023). With less than half of the enrolled undergraduate population having a rural background (Mijares et al., 2022), many undergraduate animal science students begin their programs without meaningful on-farm experience (Bobeck et al., 2014) Similarly, in a population of first year veterinary students, less than half have reported visiting a pig farm in their lifetime (Ventura et al., 2021). Students from non-rural backgrounds may perceive this lack of meaningful on-farm experience as a barrier to fitting into their program (Bobeck et al., 2014). Accordingly, hands-on animal experiences through on-farm laboratory and formal class sessions are highly desired by students (Ragland, 2023) and have been found to be effective for teaching student skills such as animal handling (Bundy et al., 2019).

On-farm experiences are effective for increasing student understanding of animal-related topics (Reiling et al., 2003). This is particularly important for complex subjects, like animal welfare, that require specific knowledge and skills but are not routinely taught in the United States (Johnstone et al., 2019, Mijares et al., 2021). For example, first-year veterinary students demonstrate improved understanding of species-specific on-farm animal welfare challenges after visiting a commercial swine farm (Ventura et al., 2021). Similarly, areas of veterinary and animal science that receive less interest as a future career path for students may benefit from on-farm exposure (Foster et al., 2018). However, on-farm biosecurity protocols and limited course contact hours may reduce an instructors ability to provide adequate on-farm experiences.

Technology for Education

Incorporating technology for the purpose of experiential learning may help mitigate the challenge of increasing on-farm exposure for students. Student access to smart phones, tablets, and laptops provides several potential opportunities for integrating alternative or hybrid classroom formats in the university classroom (Ali, 2019; Marougkas et al., 2023; Dickfos et al., 2014; Grassini, 2023). In fact, many veterinary schools routinely utilize models and various non-traditional technologies for teaching veterinary students essential skills, commonly resulting in similar or improved learning outcomes compared to traditional techniques involving living animals (Zemanova and Knight, 2021).

Virtual reality (VR), which allows users to immerse themselves in virtual environments, has emerged as a leading technology to provide an alternative method to traditional face-to-face teaching (Brooks, 1999). The appeal of VR in the animal science classroom lies in its ability to supplement on-farm laboratory experiences with virtual simulations that can be accessible anywhere with a VR headset (Kavanagh et al., 2020). However, few studies integrate VR into agricultural classrooms (Rapolu, 2023).

Purpose and Research Questions

The primary objective of this study was to evaluate student perceptions of a VR farm tour using pre- and post-surveys detailing their experience. Surveys encourage students to reflect on their perceptions of VR and opinions regarding classroom implementation (Cicek et al., 2021). The questions guiding this research were as follows: What are the factors influencing student perceptions of VR farm tours, and who do students feel would benefit greatest from their inclusion in the classroom? We hypothesized that students would report an overall positive experience after completing a virtual farm visit. Additionally, we hypothesize that students would recommend the tours to other classmates without livestock experience.

Methods

The study design was approved by Texas Tech University's Institutional Review Board (Protocol # IRB2021-190) and North Dakota State University's Institutional Review Board (Protocol # 0003800).

Virtual Reality Model Creation

A third party (Be More Colorful LLC., Fargo, ND) specializing in VR module development was hired to work with experimental personnel to develop two separate VR tours, 1) a commercial dairy facility (referred to as 'dairy module' throughout), and 2) a university farrow-finish swine facility (referred to as 'swine module' throughout). The third-party company also stored and hosted the tours so they could be viewed through VR headsets or online. Each tour included an immersive farm tour using virtual reality technology and an interactive, self-guided computer desktop-based farm tour. The fully immersive VR tours lasted six (swine) or eight (dairy) minutes and consisted of narrated video footage describing husbandry and production practices as the tours moved through each portion of the facilities. The self-guided, desktop-based version of the tours allowed users to move through the facilities at their own pace. These tours were not fully immersive, but the user could still use their VR goggles and cursor to view all angles within the room as if they were standing in it. For this study, the students were asked to navigate the desktop-based farm tour with VR headsets. As the user moved through the facilities, several clickable icons (called "hotspots") located within each of the rooms were linked to information regarding the stage of production, videos with facility employees, or case-study type questions related to husbandry and welfare topics for the user to consider.

Recruitment and Population

The data collection processes occurred at North Dakota State University's (NDSU) main campus in Fargo, ND, Texas Tech Univeristy's (TTU) main campus in Lubbock, TX, and TTU School of Veterinary Medicine (TTU SVM) in Amarillo, TX. TTU currently enrolls approximately 30,000 undergraduate students, 7,000 graduate students, and 280 veterinary students. All 280 veterinary students were selected for recruitment, and the recruitment pool for graduate students was approximately 110 full-time students, studying in either the Department of Animal and Food Sciences or the Department of Veterinary Science. Lastly, TTU had approximately 2,500 in the College of Agriculture, with 1,200 undergraduate students who have a major in the Department of Animal and Food Sciences.

At NDSU, a total of approximately 9,600 undergraduate students are enrolled full-time. About 900 of those students are pursuing a major within the College of Agriculture, Food Systems, and Natural Resources. A total of 1,900 graduate students study at NDSU, with close to 400 graduate students in the College of Agriculture, and 20 graduate student in the Department of Animal Sciences. Any students pursuing a degree in agriculture were able to participate in the study, though the majority of recruitment occurred in Animal Science and Veterinary programs.

Between October 2022 and January 2023, students at each of the data collection locations were recruited in person via classroom visits by experimental personnel or via email (e.g. student listserv). Students were asked to voluntarily participate in the study and complete an anonymous survey detailing their experience during the data collection process. Recruitment emails were sent out one week before data collection occurred. After contacting experimental personnel following classroom visits or responding to the email asking for voluntary participation, students were assigned an identification code (ID) to use in a calendar invite to schedule a time and station to undergo the data collection process. The ID codes allowed no public information to be accessible in the study.

Demographic

A total of (n = 71) students participated in the study consisting of thirty-three undergraduates, thirty-one graduates, and six veterinary students. Students who pursued general agricultural or veterinary degrees were considered the sample population for the study. As convenience sampling was used, student module experience was not balanced by any demographic information. Demographic information for the study is given in Table 1.

Data Collection Procedure and Student Survey

Students enrolled in the study were asked to complete a pre- and post-experience survey (Survey Monkey Inc., San Mateo, CA). The pre-survey was given to students before using the VR headset and included questions related to student experience with VR and augmented reality (AR), background in agriculture, and familiarity with various welfare practices in swine and dairy production. All results from the pre-survey are provided in Table 1. Participants then self-selected which species tour they wished to 'visit' for this study. Participants were required to remain with their species selection for both the fully-immersive VR module and the desktop-based tour.

After completing the pre-survey, the correct fully-immersive species tour was loaded onto the VR headsets (Occulus 2, Meta Platforms Inc., Irvine, CA). Each student received brief instruction on how to navigate the headsets, with additional assistance provided whenever requested. The students were directed to the desktop-based farm tour (viewed on a web browser within the VR headset) after completing the fully-immersive VR tour. Similar to the fully-immersive VR tour, students received a brief description of how to navigate and utilize the hotspot icons located within each of the facilities' rooms. Students were given as much time as they wanted to complete the desktop-based tour before completing a post-tour experience survey. The survey utilized a Likert-type scale, featuring a one-to-five-point format (1 = Strongly Disagree, 2 = Disagree, 3 = Neutral, 4 = Agree, 5 = Strongly Agree) to assess participants' perceptions of the tour. The statements students rated from Strongly Disagree to Strongly Agree were as follows:

1. I enjoyed using the virtual reality experience.
2. I think a virtual reality farm is a good supplement to visiting a farm.
3. I would recommend virtual reality farms to my classmates.
4. I did not gain any new knowledge using the VR walk through.

Table 1

Demographics of students who completed the study.

		n = 71	Percent (%)
University	North Dakota State University	17	23.9
	Texas Tech University	42	59.2
	Texas Tech University, School of Veterinary Medicine	12	16.9
Participant	Veterinary Student	6	8.5
	Graduate Student	33	46.5
	Junior/Senior	17	23.9
	Freshmen/Sophomore	15	21.1
Virtual Reality (VR) experience	Experience with VR	15	21.1
	Experience with AR[1]	13	18.3
	Experience with VR and AR	14	19.7
	No experience	29	40.8
Agriculture background	I grew up in a farming community but did not grow up on a farm or ranch	18	25.3
	I grew up in a community with very little farming or ranching	20	28.1
	My family uses a farm or ranch as a hobby	18	25.3
	My family uses a farm or ranch as a primary source of income	15	21.1
Gender	Women	51	71.8
	Men	20	28.2

Note. [1]AR = Augmented Reality

5. Overall, I found the virtual reality headset difficult to use.
6. The virtual reality scenario was challenging to answer.

Agreements to the above statements were used for quantitative analysis outlined below. In the post-survey, participants were also asked to respond to the following open-ended questions:

1. What suggestion would you make to the producer to improve welfare on the farm? What components of the virtual reality module helped you to come to this conclusion?
2. Who do you think would benefit the most from virtual reality farm tours? In what ways?

The responses to the open-ended questions in the post-survey were used for thematic analysis and themes were identified in the responses.

Quantitative Analysis

Data were analyzed as a mixed ANOVA using SAS 9.4 (Cary, NC). The model included fixed effects of which species module the student experienced (swine or dairy), previous technology experience (experience with VR, experience with augmented reality, experience with both VR and AR, or experience with neither VR nor AR), and gender. In some models, gender was influential and remained a fixed effect. When gender did not influence the results, it was changed to a random variable and maintained in the model. Data for gender is provided in the results when relevant to the statistical model. Random variables included agricultural background, university, and educational level. A p-value of ≤ 0.05 was established as the level of significance. Tukey-Kramer adjustment was utilized for multiple comparisons.

Qualitative Analysis

Data were analyzed using qualitative thematic analysis to identify and interpret themes within open-ended survey responses (Clarke and Braun, 2017). The methodology to complete the thematic analysis followed the methods laid out by Braun and Clarke (2006). Briefly, one coder read through all written responses to the respective question and generated initial notes (codes) to highlight the main point in the written response. Following this, themes were generated and mapped to capture the responses relevant to the research question (see Figure 1 for an example). This involved identifying and interpreting patterns of themes, which were then reviewed and named in the final results. Between the two species, six common themes emerged from the analysis. Questions that were skipped by participants were excluded from the analysis.

Results

Virtual Reality Student Experience Statements

Students were asked to rate four statements during the post-experience survey, which are reported in Table 2. Starting with the first statement, *"I enjoyed using the virtual reality experience."*, student feedback revealed that among the factors examined, only the effect of previous VR technology experience showed significance ($F_{(3,57)} = 3.82$, $P = 0.01$). Mean estimates showed that students with VR experience rated this statement higher than those with only previous AR experience ($P = 0.02$). Statement ratings from students with both VR and AR experience or no experience were intermediate but did not differ ($P > 0.05$) from those with only VR experience or those with only AR experience. Additionally, reported gender influenced the response to this statement, with women overall rating it higher (3.63 ± 0.4) than men (2.70 ± 0.5; $F_{(1,57)} = 4.32$; $P = 0.04$). The statement rating was not influenced by species experienced ($P > 0.05$).

For the statement, *"I think a VR farm is a good supplement to visiting a farm."*, only prior technology experience had an effect on student rating ($F_{(3,57)} = 3.96$, $P = 0.01$). Students with only previous VR experience had a higher rating of the statement compared to those with only previous AR experience ($P = 0.02$). Statement ratings from students with both VR and AR experience and students with no previous VR or AR technology experience were intermediate but did not differ ($P > 0.05$) from students with only VR experience or those with only AR experience. The statement rating was not influenced by gender or species experienced ($P > 0.05$).

For the statement, *"I would recommend VR to my classmates,"* the results indicated that previous technology experience had an effect on student rating ($F_{(3,57)} = 3.33$, $P = 0.03$). It was found that students with only previous VR experience rated the statement higher compared to those with only previous AR experience ($P = 0.03$). Students with both VR and AR experience and those with no prior VR or AR experience were not different from students with only previous VR experience or only previous AR experience ($P > 0.05$). The statement rating was not influenced by gender or species experienced ($P > 0.05$).

For the statement, *"I did not gain any new knowledge using the virtual reality walkthrough,"* previous technology experience had an effect on ratings ($F_{(3,57)} = 3.90$, $P = 0.01$). Students with only previous VR experience had the lowest average rating, which differed from students with only previous AR experience ($P = 0.01$). Students with both VR and AR experience and students with no previous AR or VR experience were intermediate to students with only previousVR experience and only previous AR students but were not different ($P > 0.05$). The statement rating was not influenced by gender or species experienced ($P > 0.05$).

The statement, *"Overall, I found the virtual reality headset difficult to use,"* was not influenced by previous technology experience, gender, or the species experienced ($P > 0.05$).

Table 2

Comparison of student reported experience following a fully immersive VR video tour and separate self-guided, desktop-based tour of the same farm, organized by previous technology experiences.

Statement	VR[1]	AR	Both	None	F-value	*P*-value
I enjoyed using the virtual reality experience.[2]	4.3 ± 0.5a	2.4 ± 0.6b	2.8 ± 0.5a.b	3.1 ± 0.5a.b	3.82	0.01
I think a virtual reality farm is a good supplement to visiting a farm.	4.3 ± 0.4a	2.6 ± 0.4b	3.0 ± 0.4a,b	3.0 ± 0.3a.b	3.96	0.01
I would recommend virtual reality farms to my classmates.	4.3 ± 0.5a	2.6 ± 0.5b	3.0 ± 0.5a,b	2.9 ± 0.5b	3.33	0.02
I did not gain any new knowledge using the VR walk through.	1.9 ± 0.4a	3.66 ± 0.4b	3.0 ± 0.4a,b	2.99 ± 0.4a,b	3.90	0.01
Overall, I found the virtual reality headset difficult to use.	2.0 ± 0.4	3.2 ± 0.4	2.6 ± 0.4	2.7 ± 0.4	2.10	0.11
The virtual reality scenario was challenging to answer.	3.2 ± 0.3	3.5 ± 0.3	3.4 ± 0.2	3.2 ± 0.2	0.30	0.83

Note. Presented data are the least square mean values ± standard error). Statistically significant differences ($p < 0.05$) between a and b are indicated with an asterisk.
[1]VR= Virtual reality, AR = Augmented reality, Both = Students with reported experience in both VR and AR ; None= those who have no reported experience with either VR or AR.
[2]Ratings are based on a 1 to 5 scale, with one representing 1= Strongly disagree, 2 = Disagree, 3 = Neutral, 4 = Agree, 5 = Strongly agree.

Students were asked the following statement, *"The virtual reality scenario was challenging to answer."* Gender was influential in reported ratings ($F_{(1,57)} = 4.76$ $P = 0.03$) with men rating it higher (3.64 ± 0.2) than women (3.1 ± 0.2). The statement rating was not influenced by previous technology experience or species experienced ($P > 0.05$).

Qualitative Analysis

Qualitative analysis was performed to identify themes present in students' written responses. Themes were similar between swine and dairy experiences, therefore the combined themes are presented.

The first question, "What suggestion would you make to the producer to improve welfare on the farm? What components of the virtual reality module helped you come this conclusion?", resulted in 51 responses. Of these responses, 9 provided no relevant information to the question or highlighted current practices which maximize welfare. The most common suggestion was related to the environment. Twenty-six students mentioned the environment as an area in need of the greatest improvement, with 9 highlighting cleanliness. Other common themes for this question were housing (3), flooring (3), increased space (4), different types of bedding (3), and temperature management (2). Similarly, 7 students requested increased biosecurity practices, with 3 students specifically mentioning access to a shower on farm. Other suggestions were vague or cited biosecurity specifically. For example, one student mentioned, "Pigs in any stage of life need to stay healthy. For this reason, it is important to ensure biosecurity measures and constant check-ups with the pigs in the facility."

A total of 5 students cited enrichment as a suggested practice, with 4 requesting environmental enrichment and one focusing on social enrichment. Three students mentioned general employee practices. For example one student reported "The room that had medicine and cleaning clothing… was not very clean and there were human food/drink in there. These should be separate area away from any produced used…". Three students also suggested the removal of the bull from the dairy, as this barn practices live cover for outdoor housed transition cows.

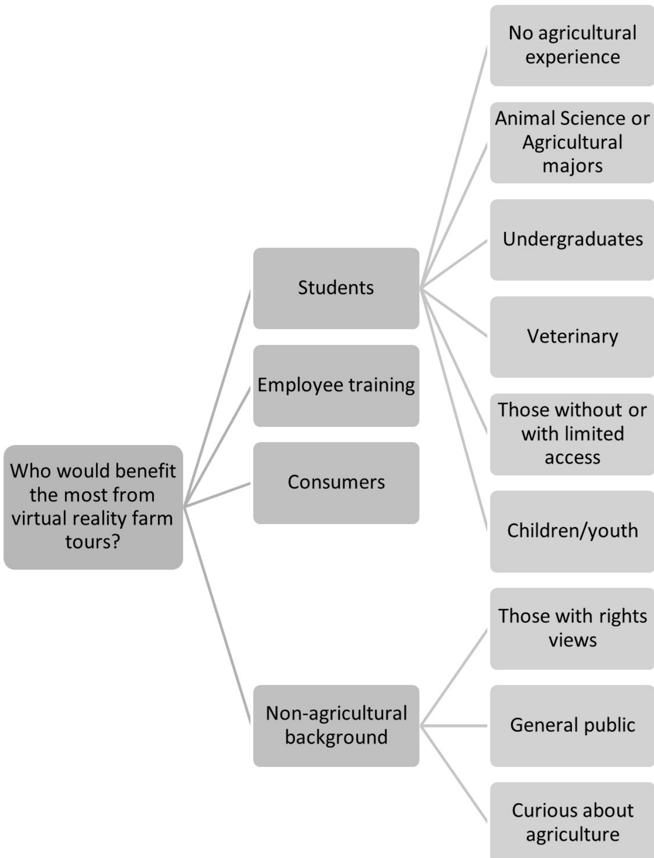
The second short answer question posed in the post-experience survey was "Who do you think would benefit the most from virtual reality farm tours? In what ways?" A total of 71 responses were collected. A flow chart of responses is represented in Figure 1.

The most common suggestion were students (43 responses). More specifically, common suggestions were for any students without previous agricultural experience (9 responses) or for those with an animal science or agricultural focus (11 responses). Three individuals specifically mentioned the value to undergraduate students, and 3 suggested veterinary students. Finally, 8 respondents suggested individuals with limited access to farms, specifically those who cannot access farms due to financial, health, and location restrictions in the United States. Other student suggestions included "kids" (4 respondents) or large groups (1 respondent).

The second highest suggestion was for any person without an agricultural background (22 responses). For example, "People who did not grow up in the ag industry, and VR would give them the opportunity to tour farms". Three respondents specifically suggested the virtual farm tours for those who support animal rights. Additionally, 2 respondents focused on those with a general agricultural interest and 3 respondents recommended the general public.

Figure 1

A mapping of themes which emerged during the qualitative analysis. Answers are based on the question, "Who would benefit the most from virtual reality tours?"



The 3rd highest suggestion for the second short answer questions was to use the virtual farm tour for employees (9 responses). Recommendations included general employee training, executives of large farm corporations, and as a way to show employees how animal production occurs on other farms and across species. Lastly, other suggestions included consumers (4 responses) and one individual suggested use of the VR modules as a way to show animal production in the United States to an international audience.

Discussion

The data from this study revealed several main takeaways about student perspectives related to the use of VR for experiencing farm tours. Interestingly, our study indicates that students with only previous AR experience were less receptive to VR technology compared to students reporting only previous VR experience. Specifically, those who reported having only previous AR experience reported lower enjoyment after completing their VR farm tour. Their rankings related to whether VR farm tours were a good supplement to visiting a farm and their willingness to recommend the VR farm tours to a classmate were also lower than students with only previous VR experience.

One explanation for this result may be related to the technological requirements needed to successfully navigate a fully-immersive VR experience compared to other previous AR experiences. Students in the current study were provided with a brief VR technology tutorial before their farm tour experience. Nevertheless, it was not uncommon to assist a user more than once in navigating the VR technology during their use. Additionally, while not significantly different from any of the other previous-technology-experience student groups, students with only previous AR experience ranked the statement *"Overall, I found the virtual reality headset difficult to use" highest* (*i.e.* greater agreement with the statement) and more than 1 point higher than students with only previous VR experience. Similarly, students without prior AR or VR experience ranked the statement *"I would recommend VR to my classmates"* low, demonstrating that barriers to use the technology exist.

Virtual reality is a highly-immersive experience that requires technology not routinely used by animal science and veterinary students in a classroom setting. Alternatively, augmented reality relies less on simulated graphical displays, often placing simulated visual graphics within a user's actual environment through the use of a phone or tablet (Milgram et al., 1995). Usability of VR for touring livestock facilities has been evaluated in past studies, with students indicating that tablet-based swine barn tours were more usable than a fully-immersive VR tour but less realistic and entertaining (Schütz et al., 2022). Additionally, Nguyen et al. (2024) reported a usability score of 63.9 (out of 100) by study participants experiencing a simulated VR dairy barn tour. This suggests the importance of a structured learning period for students to become comfortable with VR technology prior to regular use in a classroom setting. Future work in this area should attempt to determine the underlying effects of specific past-technology usage on future VR enjoyment and usability related to livestock farm tours.

Aside from the technological aspects of VR compared to AR, some published data indicates that VR and AR each lend themselves to different aspects of learning. Huang and colleagues (2019) found that AR allowed students to learn more effectively when audio is tied to spatial aspects of the scenario compared to VR. The authors indicated this may be due to increased cognitive demands required for students to adequately learn content while experiencing a fully immersive VR scenario compared to AR. In contrast, VR resulted in better immersion and engagement for the user compared to AR.

In the current study, students with only previous VR experience ranked the statement *"I did not gain any new knowledge using the VR walkthrough"* lower (*i.e.* greater disagreement) than students with only previous AR experience. This result partially agrees with previous work reporting that past experiences with simulated environments improves learning in future simulations (Ng et al., 2018). The remaining previous technology groups (none or both AR and VR) in the current study were intermediate but did not differ from the other groups. One potential explanation for previous-AR-only students' relative greater agreement with this statement may be that they experienced difficulty concentrating on the VR scenario educational content when fully-immersed. However, if increased cognitive requirements were driving a lack of gaining new knowledge during the VR tour, we would also expect to see a similar result in the group of students without previous VR or AR experience. Alternatively, it is also possible the tour simply was not advanced enough for the students with only previous AR experience to gain new knowledge compared to the VR-only student group. Further study related to cognitive aspects of learning as it relates to AR and VR modalities is needed to determine best practices for developing effective teaching content for use in the classroom.

Animal welfare-specific courses are not routinely taught at the undergraduate-, graduate-, and veterinary-levels in the United States (Johnstone et al., 2019, Mijares et al., 2021), despite students identifying animal welfare as an important topic for inclusion in their courses (Colonius and Swoboda, 2010; Mijares et al. 2021). Further, students perceive animal welfare to be an important area of knowledge for their future careers (Mijares et al., 2021). This lack of animal welfare-specific knowledge may leave students without the skills needed to respond to common on-farm animal welfare challenges. Therefore, VR opportunities for learning about animal welfare may provide a highly useful option for students, particularly in cases where access to a farm is limited or students need mitigation skills related to infrequent but serious animal welfare concerns.

Our qualitative questions revealed that students were able to successfully identify relevant areas of improvement for animal welfare and a specific audience to recommend the modules. For example, many students suggested cleanliness and increased biosecurity as needed improvements in the VR modules, both highly important topics for maintaining good on-farm welfare (Alarcón et al., 2021). As a note, the videos were filmed in March in the upper Midwestern United States, making mud and dirt a true issue to this region in the spring.

In regard to a specific audience for recommending the modules, most student responses indicated that a “student” population would benefit most, regardless of whether they were from a non-agricultural or agricultural background. Previous work has shown that animal welfare education researchers have concluded that animal welfare education should target children and parents (Muldoon and Williams, 2021), veterinary students (Main, 2010), and undergraduate students (Mijares et al., 2021). Students in our study also suggested consumers and employees. Overall, several target populations could benefit from virtual farm tours, regardless of background or educational status, though most suggestions do target individuals seeking to learn (i.e. students at any level).

Lastly, simply providing students a moving animal can have a positive influence on learning. PreviousVR work has allowed users to integrate themselves into a computer-based generated environment, instead of using images or videos of actual environments (Al-Gindy, 2020). Our study allowed students to be immersed within the farm facilities usingimages of real farm animals and not computer-generated images. George and Cole (2018) explain that the presence of live animals in a simulation increases student engagement by immersing students into the environment as if interacting with them. Additionally, researchers have worked to understand the presence of an animal in the classroom on student learning, and an animal, live or recorded, will improve student knowledge (Hummel and Randler, 2011). In the future, we seek to understand the effects of virtual farms against written versions of the same information to measure the effect on knowledge.

Conclusion

Virtual reality farm tours may be an effective method for increasing student exposure to farm environments and improving student understanding of on-farm animal welfare challenges. Consideration should be given to students’ technology skills before implementing a virtual reality educational experience. Students may experience a learning curve to using the technology, and require assistance in navigating the VR farm tour. Regardless of students’ perceived quality of the experience, they were able to recommend various populations who may benefit from VR for learning about animal welfare. More research is needed to identify barriers to using VR experiences by students to provide a farm tour.

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