

Taking Tractor Safety to the Virtual Limit

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Introduction and Literature Review

During 2019, the agriculture, forestry, fishing, and hunting industry reported 573 fatal injuries and 167 fatalities resulted from contact with an object or equipment (U.S. BLS, 2020). During this same year, 84 youth ages 19 and below suffered fatal injuries while working on farms and ranches in the United States. Statistics like these support the need for farm safety education. Programs of multiple types have been developed to help train and educate students in safe tractor operation from traditional methods to more creative methods (Koc et al., 2012; Vincent et al., 2019).

Given the hazardous situations that can occur on machinery while working and during training, educators believe that Virtual Reality (VR) can be used as an alternative training method (Kizil & Joy, 2001). VR can be an efficient tool for K-12, colleges, and universities to provide their students' knowledge and skill of complex mechanisms and theories (Lee, 2012). As VR proves to be an effective method for training students than fully traditional methods, the need for more realistic simulations creates the opportunity for us to incorporate VR as an alternate means of training students and workers (Stredney et al., 2008). Currently VR is used as a training method in the Army, Air Force, surgical training, industrial safety training, and pedestrian safety training (Aggarwal et al., 2006; Hurtado et al., 2010; Li et al., 2018; Pellas et al., 2021).

How it Works

The virtual reality program utilized for this study is a product of a USDA-NIFA funded grant objective under a larger project titled, Safety in Agriculture for Youth (SAY). The VR program was developed from the National Safe Tractor and Machinery Operation Program (NSTMOP) driving and skill course. In the virtual environment, participants are required to complete pre-op checks on a tractor and drive the tractor through a course modeled after the NSTMOP certification course. The program was developed as a supplemental resource for the live offering of the course so that students can practice while someone else is on the machine, while at home or at a distance, or to accommodate social distancing and COVID requirements. The program operates on the Oculus Quest/Quest 2 VR headsets.

The VR experience consists of three different areas, the first area consists of a stationary tractor that allows students to move around it and interact with different points of interest related to safety. The second area is a skills test, which allows students to interact via hitching an implement, attaching a PTO and making hydraulic connections. The last area is a driving course where students have to answer questions that act as preoperational check related to machinery operation. They can then mount and drive the tractor through an obstacle course that resembles the course they will drive during certification. Points can be accumulated while driving by striking or knocking over obstacles, students should try to complete the course with as little points as possible. Once completed, they get a scorecard detailing their progress, and students' can save their data may within the headset to be accessed on the teachers' computer for grading.

Students completed a 65 question survey after completing the VR experience and were on a 10-point scale from Strongly Disagree to Strongly Agree. The purpose of the evaluation is to focus on students user experience and the constructs that make up their user experience, as well as their perceptions of the VR environment. Formative results will be used to improve future versions.

Results

At this time data collection is still ongoing. Data from 15 secondary agricultural education students are reported in this abstract. Final user experience data will be available in May for 100 students. Means for all the constructs and the overall user experience can be seen below in Table 1.

Table 1

Descriptive Statistics of Students' User Experience

Construct	Mean
Presence	7.7
Engagement	7.9
Immersion	7.3
Flow	6.8
Usability	6.9
Emotion	7.6
Skill	7.5
Judgement	7.7
Experience Consequence	8.4
User Experience	7.4

The data represented here indicates that users had a moderately positive user experience from the VR program. Qualitative comments by students indicated VR was a fun and interactive way to engage with tractor safety. Negative comments reported by students included several after-effects such as headaches, eyestrain, not being able to remember the controls or the sequence of activities. Ultimately students felt that it was exciting to use the Oculus headset in class.

Future Plans

Currently this program is available within the state of Ohio. Future plans include launching the program nationally for agricultural educators and extension professionals teaching tractor safety programs or training. Advice to students or teachers interested in using this technology is to take the time to become familiar with the Oculus headsets and controllers to relieve confusion around the functions and controls of the experience. Adequate time should be allotted in class to account for acclimation to the technology and exploring the VR environment. Teachers completed this evaluation using one VR headset and expressed that others should explore options for funding to get a bundle of headsets for the classroom to alleviate the downtime of other students. Teachers should also coordinate with their IT departments to make sure they access to necessary websites (Oculus.com, Facebook, etc.)

Costs/Resources

There is a small investment to incorporate VR technology into the classroom. Users need an Oculus/Oculus 2 headset with controllers (\$350), a USB A/B/C to USB C (\$10) cable, a computer/laptop with internet access, and a downloaded SideQuest Store Application.

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