Using a Virtual Reality Trainer to Improve School-Based Agricultural Education Teachers' Welding Performance

Ashley Thompson and Justin Pulley
Tarleton State University
Department of Agricultural Education and Communication
College of Agriculture and Natural Resources
1333 W. Washington
Stephenville, Texas 76402
ashley.jenson01@go.tarleton.edu
jpulley@tarleton.edu

Introduction/Need for Idea

Despite over half of all SBAE teachers in the United States offering agricultural mechanics courses, and the perception that it is one of the most important course offerings available to students enrolled in SBAE programs (Whitehair et al., 2020; Burris et al., 2005; Lafferty, 2004), teachers are often dangerously unprepared to teach this subject. One reason they do not feel prepared to teach agricultural mechanics is a lack of course offerings available at the postsecondary level. Only half of all preservice agricultural education teacher preparation programs offer agricultural mechanics courses; the ones who do offer them do not offer them in a high enough quality or quantity to increase self-efficacy much, if at all, especially in the crucial area of laboratory instruction (Granberry et al., 2022; Clark et al., 2021; Saucier & McKim, 2011).

One way to supplement welding instruction at the postsecondary level is through virtual reality welding trainers. VR welding trainers allow for experiential learning, problem-based learning, social cognition, and reflective practice to take place, thus increasing welding ability and self-efficacy in an environment free from the dangers of a live welding scenario (Pulley et al., 2023; Heibel et al., 2022; Dalgarno & Lee, 2010; Whittington, 2005). While there have been studies about the effects of VR welding trainers on the ability of undergraduate agriculture students (Heibel et al., 2022; Ramos et al., 2022), neither of these studies have been specific to preservice SBAE teacher welding ability, which is where this idea hopes to fill that gap.

How it Works

This innovative idea was implemented in a laboratory-based agricultural mechanics course geared towards preservice SBAE teachers over a period of two weeks. The idea sought to determine whether the participants' ability to perform SMAW welding in a virtual setting increased because of using the Lincoln Electric VRTEX 360 Compact welding trainer. This trainer scores virtual welds completed by participants on a scale from 0 to 100 depending on factors such as work angle, travel angle, travel speed, distance and position (Lincoln Electric, 2023).

During week 1 of the study, participants were introduced to SMAW concepts in a lecture setting and signed up for a two-hour VRTEX 360 Compact practice period for the following week. All practice periods were held in the engines shop of the agricultural mechanics building but could be held anywhere with a table and an outlet to plug the machine into. This setting allowed the participant to have two hours of uninterrupted solo time to practice separate from the class.

During week 2 of the study, participants completed their two-hour practice period. This involved virtually welding beads on ¼" steel plate with 7018 welding rods. The first 10-15 minutes of their practice window was spent receiving safety instructions and directions on how to use the virtual welding trainer. Participants were then asked to run a virtual bead before beginning practice to establish a pre-training score. The rest of the time was spent practicing with the welding trainer; participants used visual and audial aids on the welding trainer to improve their score. At the end of the practice period, a final virtual bead was run without visual and audial aids and scored to establish a post-training score. Data was analyzed using a paired samples t-test and was tested for normality through analysis of skewness, kurtosis, and QQ plot diagrams using IBM SPSS© Version 28.0 software.

Results to Date/Implications

All participants (*n* = 8) saw an increase in scores. Pre-treatment scores ranged from 21 to 46 (*M* = 34.13), while post-treatment scores ranged from 72 to 88 (*M* = 81.13). On average, participants given a two-hour training period with the VRTEX 360 Compact virtual trainer saw an increase in scores compared to the scores earned before using the virtual trainer (*M* = -47.00, *SE* = 3.650). This difference was significant ($p = < .01$), meaning the participants would not have scored as high as they did without the two-hour practice period with the virtual welding trainer.

These results could have serious implications for the future training of preservice SBAE teachers in the SMAW process. Participants used the virtual trainer to build muscle memory and use audial and visual clues to correct their welds both during a pass and while running the following pass, which contributed to the increase in scores during the two-hour training period. The virtual trainer could be used in SBAE teacher preparation programs to build welding confidence in all preservice teachers, no matter how much or how little experience they have with a particular welding process, due to the fact it provides a learning environment that is safer and less intimidating than starting to practice welding in a live laboratory setting.

Future Plans/Advice

This innovative idea is part of a larger study working to see if VR welding skill transfers to live welding skill through use of the VRTEX 360 Compact and the Lincoln Electric REALWELD live welding trainer. Through observation of the participants, and analysis of the scores, it is clear to see the value in the visual and audial aids and instant feedback given. Because of both the increased scores and positive feedback, the VRTEX 360 Compact could be used to increase confidence and ability prior to live welding.

Considering the equipment the VRTEX 360 Compact comes with, future studies could analyze the benefits of training using different SMAW consumables, as well as the GMAW, TIG, and cutting torch processes. It could also be used to analyze the benefits of using the virtual trainer on different welding joints and positions. Future studies could also begin with a pre-treatment live welding score as opposed to a pre-treatment virtual welding score to further determine the significance of the results.

This idea could be incorporated into an agricultural mechanics class/lab by using the VRTEX 360 Compact as a training tool prior to and during live welding training. In this study, participants signed up for a two-hour solo training period that may or may not have been during the scheduled class/lab time, and all participants shared one virtual trainer. However, students could easily be rotated between the virtual trainer and either a traditional set up or a REALWELD trainer in predetermined increments to enhance their skills. Once they have been trained in how to use the machine, students can then go back and forth between these platforms as needed to practice skills they may be struggling with, then implement those skills in a live welding setting. The virtual trainer could also be used as a supplemental tool for students to use in their own time as many did in this study. Sign-ups could be coordinated with the professor to ensure proper use of the equipment.

Costs/Resources Needed

The only resource needed for this study was a Lincoln Electric VRTEX 360 Compact welding trainer. The VRTEX 360 Compact is available through your local Lincoln Electric distributor and costs $34,899. Due to the high cost, a VRTEX 360 Compact was used on loan from Lincoln Electric. It is possible to coordinate in advance with your regional Lincoln sales representative to use one of their travel units.

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