Incorporating a Computer-based Training System to Facilitate Psychomotor Skill Assessment in a University Teaching Laboratory

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Introduction

The use of computer-based training systems (e.g., simulation systems, etc.) has been identified as an effective method of providing psychomotor skill development in a variety of contexts, including welding (Byrd, 2014; Byrd, Stone, Anderson, & Woltjer, 2014; Stone, McLaurin, Zhong, & Watts, 2013), surgery (Cope & Fenton-Lee, 2008), equipment operation training (Bleazard et al., 2018), and safety training (Filigenzi, Orr, & Ruff, 2000). Topics such as welding include a wide range of psychomotor skills that can be developed through repetitive skills application and training (Byrd et al., 2014). Psychomotor skills are described as a link between physical and mental processes that are used to accomplish tasks (Byrd, 2014; Phipps, Osborne, Dyer, & Ball, 2008). Regarding welding, computer-based training systems can be used to help improve one's dexterity and skill to manipulate physical objects (e.g., a molten weld puddle, a welding electrode, etc.) to complete welding activities (Byrd, 2014; Stone et al., 2013).

As an educational technology, a computer-based training system could be implemented in agricultural education settings. In the context of a university-level agricultural mechanics course, educational technologies could help to play a role in welding-related psychomotor skill development and assessment. Further, as computer-based training systems can serve a variety of functions for users (Byrd, 2014; Stone et al., 2013), perhaps the integration of such systems could serve to assess students' welding skill development. Welding skill instruction is frequently an important component of agricultural mechanics instruction (Shultz, Anderson, Shultz, & Paulsen, 2014). Thus, it stands to reason that the incorporation of this type of system (i.e., a Miller® LiveArc™ Welding Performance Management System; hereafter referred to as a LiveArc™ system) could help to fulfill the fundamental task of providing objective, unbiased, critical welding skill assessment in a university-level agricultural mechanics course.

How it Works

Neither a virtual reality (VR) or augmented reality (AR) system, the LiveArc™ system is designed to provide real-time, instantaneous welding skill feedback through an advanced computer system that measures a series of parameters vital to weld quality (e.g., travel speed, travel angle, work angle, arc length/contact-to-work distance (CTWD), voltage, amperage, and aim). These variables are measured with a series of motion-tracking sensors and cameras that are placed in at the top of the machine's computer screen and on the electrode holder and welding gun/stinger. The LiveArc™ system can be used with the shielded metal arc welding (SMAW), gas metal arc welding (GMAW), and flux-cored arc welding (FCAW) processes. The LiveArc™ system is designed to function in a variety of weld positions as well, including the flat, horizontal, and vertical positions, maximizing its flexibility as an educational tool. The LiveArc™ system is shipped pre-programmed with a variety of welding assignments; users can add customized assignments as well, each with programmable tolerances. Further, the LiveArc™ system can be used in either *Simulation Mode* or *Weld Mode*, both of which collect welding skill data and provide numerical score outputs based on performance. Based on the weld variable tolerances set up by the system administrator (i.e., the Agricultural Mechanics Applications

[AgEdS 388] course instructor), the LiveArc™ system can be programmed to provide visual, auditory, or physical feedback when a user exceeds the designated tolerances. The LiveArc™ system computer interface can be used to store and track individuals' welding skill performance data over time (Miller Electric, n.d.).

During the Spring 2018 semester, the AgEdS 388 course instructor, in conjunction with the co-author of this abstract, purchased a LiveArc™ system and began incorporating the LiveArc™ system into the welding portion of the course, which lasts for approximately 10 weeks each semester. The purpose of the acquisition and subsequent inclusion of this educational technology was to provide critical, objective welding-related psychomotor skill development and assessment procedures for students. We wish to note that because delays in implementation occurred due to a variety of factors (e.g., shipping delays, instructor system use training delays, etc.), the LiveArc™ system was not included within the full scope of the 10 weeks of welding skill training offered in the AgEdS 388 course. Rather, the course instructor was able to incorporate the LiveArc™ system into the final weld exercise of the semester, which is a 2F horizontal tee weld performed with the GMAW process. Because this was a custom assignment for this course, the course instructor programmed it into the LiveArc™ system. Students were asked to first use the *Simulation Mode* to perform the test weld. Each student who scored a composite score of at least an 80 was permitted to attempt the same weld in the *Weld Mode*. The composite score achieved during the *Weld Mode* served as the score for the weld exercise.

Implications

The AgEdS 388 course students found the LiveArc™ system to be a beneficial educational tool that can accurately assess their welding skill performance. Perhaps more importantly, the use of a LiveArc™ system removed human subjectivity when evaluating welding skill performance. As educational technologies continue to evolve, adopting and including such items in agricultural education settings will become increasingly paramount for student and instructor success (Smith, Stair, Blackburn, & Easley, 2018).

Future Plans, Advice to Others, & Costs

We anticipate that the LiveArc™ system will become a more permanent welding skill assessment tool within the AgEdS 388 course at Iowa State University (ISU). Additionally, we plan to procure additional funds to purchase more LiveArc™ system units soon, as well as institute an experimental study involving the system. The LiveArc™ system cost $49,430.00 to procure from a university-approved vendor. Two grants from ISU computer technology fee funds and funds from the Department of Agricultural Education and Studies were used to fund the system. Neither a welder nor welding consumables (e.g., wire, electrodes, etc.) were included as part of this total cost. The LiveArc™ system is designed to work with modern Miller Electric welders (Miller Electric, n.d.), so agricultural mechanics laboratories that use older equipment may have to purchase a newer welding system to use in conjunction with the LiveArc™ system. We do suggest that university-level faculty who are interested in procuring a LiveArc™ system work with any available computer technology initiative funds at their respective institutions, as well as with industry stakeholders, to help offset the costs of purchasing a system and any additional welding equipment needed.

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