



6th International Conference on Applied Human Factors and Ergonomics (AHFE 2015) and the
Affiliated Conferences, AHFE 2015

User Experience in Augmented Reality applied to the Welding Education

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Abstract

Like any other new technology there are lots of constraints and limitations to augmented reality that need to be considered when designing the user experience. The purpose of this article is to report the user experience of AR technology in welding education for future studies and applications. AR technology of the welding process consists of indirect vision of welding helmet, called HMDs (Head Mounted Displays) coupled with the welding torch and the portable device containing peripherals and software for the simulation of welding source, positioning system and plate with the material base. The Welding simulation training was conducted for a group of 12 students of Welding discipline of Mechanical Engineering course at the Federal University of Paraná. The equipment used to conduct the study was the Soldamatic, in which we performed the welding simulations in embedded plates with augmented reality and software called "Teacher". The simulator is equipped with a mask similar and SMAW (Shielded Metal Arc Welding) identical used in the actual welding torches MIG / MAG and TIG in real situations. The results of this study can help the teacher with relevant parameters for the organization of training, as it guides as in the present case study, the need to insert a phase perception of pre-training in AR. It also suggests further studies in order to compare the performance index of learning in simulated welding environment when associated with a previous training perception of AR.

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Peer-review under responsibility of AHFE Conference

Keywords: augmented reality, welding training, AR technology

1. Introduction

It can be inferred that the practice of manual welding will always be a process of extreme importance to the industrial sector. Certain tasks involving the welding process cannot be performed by robots due to the complex geometry or the location of the parts to be welded. The manual welding is employed mainly in low-demand

production systems, where the process cannot be automated. In all these cases the welding process must be carried out by highly qualified professionals.

The combination of new information and communication technologies (ICT) applied to the teaching and learning of knowledge, has expanded greatly in recent years also currently covering virtual display technologies. Among the representations of the reality of the virtual environment combined with human interaction for learning, it emphasizes Augmented Reality (AR) technology because it has a flexible physical structure, in a much more compact form that allows its use in different spaces with the use of equipment and easy shipping and handling software. Augmented reality (AR) is a newly emerging technology by which a user's view of the real world is augmented with additional information from a computer model [2]. Increasingly popular, the AR is being used in very different areas. Among the applications involving education, are those in educational, informational and military training areas, [1] AR is achieved by systems involving the capture of the image using a real camera, recognizing and adding virtual elements by the software and the projection of these elements actually linking virtual and real elements in an augmented reality.

In general the AR can be useful for training the way the information is presented 'just-in-time' "and" just-in-place. Thus the AR system applied to engineering education relies mainly on the acquisition of tacit knowledge, knowledge internalized acquired by experiences. Anastassova and Burkhard [4] present some of the advantages of the use of AR in vocational training by the student 'learning-by-doing' the construction of knowledge in an active, safe and autonomously; And the ease of manipulation of information when needed and adding to this learning process to reduce future errors, helping memorization and retrieval of information in the process-technical. Thus, this article aims to present and discuss aspects of the user experience of AR technology in the teaching of welding.

2. The AR technology and welding education

For Vygotsky [3] the subject's relation to knowledge is not a direct, but mediated and this mediation takes place via instruments and signs. Associated with the theoretical foundations of welding on literature, didactic learning tools available for mediation in teaching and welding training are:

- The welding equipment;
- Augmented reality system applied to welding;
- Virtual reality

The teaching tool uses industrial equipment requiring consumables and specific equipment for each type of welding (arc welding, TIG, MIG / MAG, etc.), in accordance with the safety standards facilities, PPE (Personal Protective Equipment) and adequate exhaust and ventilation systems.

The RA technology system of the welding process consists of indirect vision of welding helmet, called HMDs (Head Mounted Displays) coupled with the welding torch and the portable device containing peripherals and software for the simulation of the source welding, fiducial markers and plate as the base material.

About the virtual reality, there is a need HMDs or VR glasses, but there is no need for welding of physical equipment, as it recreates the virtual mode situation and the equipment and all that is perceived is not real, and when the student will hold the equipment, it is perceived by the student only as a drawing, as well as the surrounding environment, but there is no physical perception.

2.1. Advantages of educational instruments AR

One of the major advantages of using AR is the reduction of the welding time, since this technology enables the student to realize the process and have the same control process equipment. In a normal process of welding equipment, about 70% of the total time is used for the preparation of the material and 30% for the welding activity, and if you encounter an error or preparation process must reorganize all the equipment and restart all stages of the process, discarding the materials used. However, in teacher training through augmented reality, if an error occurs while performing the task can delete the file and restart the process at no additional cost and much shorter period.

Augmented reality also has a greater perception of the physical elements of the "virtual reality". In the augmented reality system the subject perceives his own hand holding the soldering equipment, because there is a real equipment that actually simulates the weight, the material and configuring the shape of the handle. Comparing the performance of the subject by AR with a conventional training in welding equipment, it has a more favorable outcome with the use of AR. It can be obtained from a learning craftsmanship of welding process in less time. The AR also contributes to a reduction in material consumption and the risk of accident in the training phase.

3. Materials and Methods

Welding simulation training was conducted for a group of 12 students of Welding discipline of mechanical engineering course at the Federal University of Paraná. The equipment used to conduct the study was an equipment of Soldamatic, composed of a simulator in which are held the welding simulations plates loaded with augmented reality and a so-called Teacher software, in which the entire simulator content can be managed, monitored and modified according to the the need for tutor. The simulator is equipped with a mask similar to that used in the actual welding Furthermore, the torches MIG / MAG, TIG and the actual coated electrode are identical. Before the start of the tests all participants signed an informed consent and informed, formalizing their participation and authorization for the release of reports and simulation data.

Was set the task to be performed by students and once selected the option of performing a welding simulation, students should connect the torch, wearing the mask and place the plate in front of him, and then start welding with augmented reality, similar to Fig.1.



Fig. 1. AR system for welding. Source:<http://soldamatic.com.br/asoldamatic.html>

A questionnaire was developed with open questions to assess the perception of first contact of the mechanical engineering students with AR technology applied after the welding training.

4. Results

Twelve students, who have the training, completed the questionnaire after performing the task in AR. All the students were in the second week of the Welding discipline. This discipline is of the Mechanical Engineering course. The course is taught in 15 weeks, with 4 hours per week, adding to a total of 60 hours. At the time of the AR training the students had not yet acquired a working knowledge, just an initial theoretical knowledge. Students in this study had never used before an AR equipment and only three students reported some initial difficulty in carrying out the activity, but also reported that this difficulty was overcome after a few minutes of the user's equipment. And the main complaints of the students were on the use of AR helmet (HMDs) and the spatial vision generated by the AR. The spatial depth of the scene and the accommodation of vision were the elements that have caused more discomfort. Among the group studied seven reported too greater discomfort with the target location, especially in the early stages, causing a natural adaptation after starting the task. The account of the perception of

the students in the use of AR, in the first welding training, was outsourced as the "quiet" terms, "relaxed" by most students, standing out the positive aspects in the application of mediation teaching tool, as shown Figure 2.

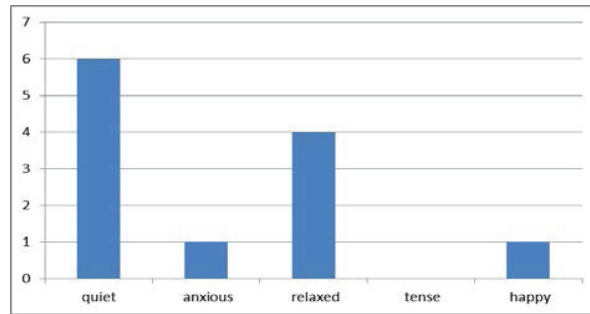


Fig. 2 - Emotional perception reported by the students during the course of the welding task in AR.

In the perception of the acquisition of knowledge in welding practice, students felt that learning occurs very fast, funny, safe and more efficiently, as we can see in the tabulation of the data shown in Figure 3.

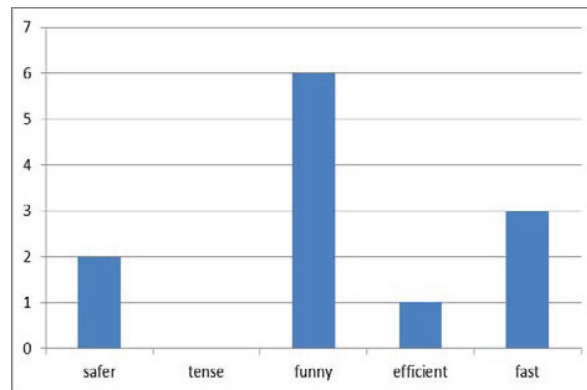


Fig. 3 - perceived aspects regarding the use of the media resource AR in the practical teaching of welding.

The main advantages presented by the students in applying the AR use in the mechanical engineering education refer to the following: we can see the weld quality; we can make mistakes and start again; we can test different types of welding and we can review a video on the task being performed, see Fig.4.

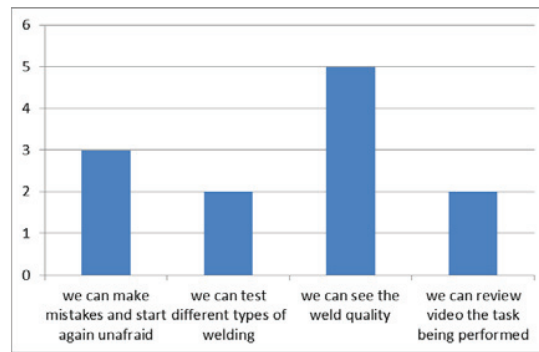


Fig. 4. Advantages cited by students as the application of the use of AR in teaching.

4. Conclusions

Students were initially very motivated to do the training, especially for the high degree of novelty both the use of the equipment, not knowing AR technology, as the practical application of welding technique. The AR training in welding occurred at the start of the course, anticipating the period of practice on real equipment. The views were very satisfactory by the introduction of technology in teaching, but were reported difficulties in visual accommodation while using the equipment. These reports refer mainly to the aspect of spatial depth of the scene, hampered the first few seconds of use. Recommending pre-training for the visual accommodation in order that efforts be made to adapt to the new way of viewing part to be welded with the perception of manual movement, which must be fully synchronized. So it emphasizes the importance of preliminary training for the adaptation of visual acuity and motor synchronization. Have the didactic point of view the use of the AR system in the practice of welding a great advantage, as media tool, is that help commands can be enabled for beginners during the practical exercises, but also after welding. The flexibility of the system allows the student to access the solder analysis module and watch all the practice performed and to verify the percentage of correct answers in each parameter evaluated and, if necessary, repeat the exercise as often as desired. And very positively, the simulated process provides students with greater security in the initial phase of training, not exposing to the fumes generated in the process, the high temperature process (electric arc region that can reach temperatures between 15000° to 20,000 ° C). As future suggestions for deepening the study we recommended a follow-up over a longer period of training for beginners. It also suggests that data is skills and welding quality can be correlated with a control group of subjects without a prior training AR.

Acknowledgements

We thank to Soldamatic company for providing the equipment for this study. And we would like thank to CAPES, *Coordenadoria de Aperfeiçoamento de Pessoal de Nível Superior* (CAPES, Brazil) for the financial support to present this article at the 6th International Conference on Applied Human Factors and Ergonomics 2015.

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