Yang, J. C. et al. (Eds.) (2018). Proceedings of the 26th International Conference on Computers in Education. Philippines: Asia-Pacific Society for Computers in Education

Design and Evaluation of a 360 Degrees Interactive Video System to Support Collaborative Training for Nursing Students in Patient Trauma Treatment

Romain C. HERAULT[a*], Alisa Lincke[a], Marcelo Milrad[a], Elin-Sofie Forsgärde[b], Carina Elmqvist[b] & Anders SVENSSON[b]
[a]*Department of Computer Science and Media Technology, Linnaeus University, Sweden*
[b]*Department of Health and Caring Sciences, Linnaeus University, Sweden*
*romain.herault@lnu.se

Abstract: Extreme catastrophe situations are rare in Sweden, which makes training opportunities important to secure the competence among emergency personnel that should be actively involved during those situations. There is a need to conceptualize, design and implement interactive learning environments that allow to educate, train and assess these catastrophe situations more often and in different settings, conditions and places. In order to address these challenges, a prototype system has been designed and developed containing immersive interactive 360 degrees educational videos that are available via a web browser. The content of these videos includes simulated learning scenes of a trauma team working at the hospital emergency department. Different types of interaction mechanisms are integrated within the videos in which learners should act upon and respond. The prototype was tested during the fall term 2017 with 17 students from the specialist nursing program, and four medical experts. These activities were assessed in order to get new insights into issues related to the proposed approach and feedback connected to the usefulness, usability and learnability of the suggested prototype. The initial outcomes of the evaluation indicate that the system can provide students with novel interaction mechanisms to improve their skills and it can be applied as a complementary tool to the methods used currently in their education.

Keywords: emergency preparedness, interactive learning, nurse specialists, trauma, 360° interactive videos

1. Introduction

Statistics from the Swedish trauma organization yearly report (SweTrau, 2014) show that traumatic events are the most common cause of death among people younger than 45 years old. About 50% of the total registered injures in Sweden are caused by traffic accidents. A research report about education in trauma and catastrophes for medical and nursing students in Sweden points out the lack of using interactive simulation training environments as well as simultaneous training of different working professionals (Persson et al., 2014). Emergency departments (EDs) provide care for ill and injured people. Health professionals working at EDs need to have the knowledge and skills to provide optimal care for their patients. In situations where patients are critically injured, there is no time to read and learn how to take care of a specific topic. This is why it is essential to continuously train employees and students to handle critical situations in order to provide optimal care. Training takes time from working hours and cannot be provided as often as it should (Persson et al., 2014). It is then important to find alternative, less time-consuming and more cost-effective ways to train caring and teamwork for employees and students. In order to address some of these challenges, a first prototype system containing an interactive 360° video that runs in web browsers (currently Google Chrome) was conceptualized, designed and developed. The content of the 360° video includes a realistic case about a patient trauma treatment at the ED unit at a Central Hospital in

southern Sweden. Different types of interaction mechanisms are integrated in the video in which learners can act upon and respond. The learner's navigation in the 360° video and interactions with the content are stored in the cloud so we can later process these data sets for further analysis. In order to validate the prototype, it has been tested in a pilot study addressing 17 students within a specialist nursing program (advanced level) and four medical experts. The main focus of this paper is to present and discuss the design, development and initial evaluation of an interactive web based 360° video environment that supports the education and training of specialist nursing students in the assessment of trauma patient treatments. The paper is organized as follows: Section 2 describes the problem domain and related work in this field. Section 3 presents our technical approach to produce and record the 360° interactive video. Section 4 describes the learning scenario, the study we conducted and our evaluation approach. Section 5 presents the analysis of the data we collected. Finally, Section 6 presents our initial conclusions together with a description of our future lines of work.

2. Problem Description, Related Work and Initial Requirements

Current learning solutions for supporting multidisciplinary specialist nursing students in assessing trauma patients are insufficient for big group of students (Persson et al., 2014). In Sweden, the training methods applied nowadays rely on the use of paper-based approach (or its equivalent in digital format) so that students, divided into groups, perform the activity having discussions and taking notes. This approach can be used for teaching and training many students at the same time. However, it lacks a realistic environment, the possibility to simulate different situations, as well as the interactivity between the different specialties required in an emergency room. Moreover, it becomes difficult for the students to reflect upon their performance given the nature of the training situation described above. To address these issues, simulations using a doll are offered to students. This process requires additional resources such as a dedicated room, a mechanized and remote-controlled manikin with dedicated software, and an operator controlling the doll and the settings of the scenario. This simulation is a good step forward, but it has some limitations related to the number of students that can use it as well as cost related issues (one operator, usually a senior lecturer, for four students, during an hour). Another alternative can be the use of a web-based simulation tools (Romero, 2006) to improve students' performance. To overcome some of these challenges, we explored how interactive 360° educational videos running on a web browser can be used as a rich based learning tool. We also carried out a pilot study to validate this approach. By recording a 360° video of a trauma team working on a simulated case in an emergency room, students were able, in groups, to visualize every aspect of the case (equipment used, specific role during the intervention, and discussion between members of the trauma team). The recorded solution should be easy to use for students with regard to the interactions offered on the screen. The use of educational videos in the medical field is not new and it has been used successfully (De Leng et al., 2007; Del Blanco et al. 2017), as well as the use of virtual reality in general (Parisi, 2015; Lateef, 2010). 360° videos have been used already in the past in the field of robotics (Nayar, 1997) and some medical companies are using this technology to showcase some medical interventions (Medical Realities, 2018). However, the use of an interactive tool using 360° videos is not common and it deserves further exploration. This paper describes our approach related to the development of an interactive 360° video tool for specialist nursing students in the context of emergency care. The current method using a manikin to teach students as described previously has a number of issues that a tool running on a web browser can solve. First, the requirements to use the web-based tool is to have one computer with an Internet connection. Second, the tool can be used by multiple groups at once. Third, there is no need for supervision or an operator for each training session. Each group can perform the activity from any classroom without special equipment. The use of Augmented Reality (AR) and Virtual Reality (VR) were considered while conceptualizing our solution. However, VR headsets are limited to one person and being cut from reality involved difficulties to communicate with fellow students. The use of AR is also problematic as students would still need to be present in a room with specific equipment. The use of a web browser allows people to directly use the tool with reasonably modern computers and fast Internet connection. One of the main requirements from the nursing department was that it should be possible to access 360° interactive educational videos using

the web-based tool from anywhere and anytime. These issues were discussed with medical personnel in order to define requirements for such a system that would complete the available tools for nursing students. Spikol et al, (2009) described a co-design methodology used to create multimedia tools that can emerge from the collaboration between researchers, designers, developers and other stakeholders. This method was used in this project to gather requirements and to develop the tool. Several activities led to discussions and to the main following requirements. 1) The web-based tool must allow students working in groups to collaborate in order to answer questions about medical emergency, 2) The tool must be inexpensive and be usable to multiple group of students at the same time, 3) The tool must be intuitive and allow for different kind of interactions with the digital content, 4) The tool must be usable in regular classroom without non-common technology, 5) Students must be able to view specific parts of the activity as they wish and be able to identify easily the role of each person in the scene. In the next section, we describe different aspects related to the technical features and functionality of the proposed system.

3. Technical Approach

In order to collect the video footage in a real ED setting at the Central Regional Hospital, the 360°-video rig GoPro Omni was used (see figure 1 below). A proprietary software allows to automatically stitch, color balance and export the video, thus making the 360 degrees video recording and production quite efficient. The automatic stitching is not perfect however, but acceptable in most situations as soon as the camera is placed in a right angle to have the stitches not directly on top of an important part of the scene (i.e. a monitor or on the patient). The physical position of the camera is an important part of the 360° filming. In regular digital video recording situations, the camera should be placed where the action happens, or use several cameras at different positions to represent the action during the editing process. By using a 360° camera, the preferable position would be at the center of the action in order to have as much data as possible (i.e. positioning a 360° camera in the corner of a room would be a waste of 90 degrees or more). Another consideration in this particular scenario is the position of the camera in terms of interferences with the work of the emergency personnel.

Figure 1. Camera Placement in the Room (left); Group of Nursing students using the Prototype (right)

As one of the main goals was to develop a web-based prototype system, the features of existing 360° HTML5 video players were explored. After investigating the pros and cons of those HTML5 players, Panellum5 was selected, since it supports most of the features for making 360° video interactive. In terms of interactions with the 360° video, the following ones have been addressed: rotation of the camera in 360°, hotspots, zooming, and changing scenes depending on the interactions performed in hotspot areas. For each one of the interaction types described above, different data sets were collected in order to analyze them after each session using learning analytics techniques. We use NodeJS on the server side and these interactions were stored as JSON data in a MongoDB database. Four main categories were considered: camera movements, hotspots interactions, speech data, and video players controls. A total of 20 different variables were recorded in these categories.

4. Prototype Evaluation

An evaluation was performed in order to investigate the use of interactive 360° video to support the learning experience about trauma treatment. The aim of this assessment was to provide us with relevant insights related to how learners and medical experts experienced the prototype, its content and the novel ways of interacting with it. Moreover, we wanted to gain some knowledge to see whether or not this kind of approach has the potential to enhance student's overall learning and knowledge construction process in comparison to traditional teaching approaches in this particular subject domain.

The scenario offered to specialist nursing students was developed and written by teachers at the specialist Nursing Program in south Sweden (Elmqvist & Österberg, 2014). The video recordings for the scenario were taken in the ED at the Central Regional Hospital. This scenario was created as case-based learning (Crosling, 2002) to reflect a real training for the trauma team. The participants of the scenario were current members of the hospital's personal (nurses specialized within emergency, ambulance, intensive, anesthetic care and medical doctors specialized within emergency, surgeon, anesthetic.). Three videos (video 1, video 2, video 3) were recorded using the GoPro Omni 360° camera. Video 1 (12 minutes) contains the parts of the scenario with a simulated patient arriving to the emergency room with life threatening injuries. The team worked through medical procedures to stabilize the patient's condition. Video 2 (8 minutes) has the same patient, but the patient's condition is getting more unstable. Video 3 (1 minute) contains a single image of a cardiac arrest in order to represent the passing away of the patient. These videos were combined in the tool to create a seemingly single video. A web-based interface was developed and used by the students to interact with the video by panning it and answering prompted questions in particular sequences of the video (depending on location and time in the 360° space). These questions were related to the patient's health and explore different issues such as identifying the blood type, what type of anesthetics should be used, or what heart bit rate was dangerous for the patient in its current condition. When the different questions popup in the video, students can collaboratively discuss and answer them accordingly. By answering these questions, the patient status will evolve based on the provided answers. Depending on the answers, videos 1, 2 or 3 will be loaded and played to reflect the choices of the students. The main learning goal of the exercise is to stabilize the patient´s health condition. The action is divided into four different acts. The first one is about the medical team presentation, the second is about receiving the patient and installing him/her in the emergency room. The third act is the examination of the patient. Finally, the fourth one is about stabilizing the patient. The fourth has also multiple outcomes, such as patient stabilized, patient in critical condition, or patient deceased.

Six different sessions with both students and experts were conducted. Participants of the study were 17 specialist nursing students from the Department of Health and Caring science aging from 24 to 45 years old with a great majority of females who never had experience with immersive videos, except for one who saw a chirurgical intervention during a livestream. The prototype was also tested with four medical experts following the same methodology. The study took place during the fall term 2018. Students and medical experts were informed about the device that they are going to use (touchable screen) before the study session begin as well as questions will appear in the video to be answered. Every participant in the group can use touchable screen to interact with 360-degree video. Students had theoretical (and in some cases practical) knowledge about caring for critically ill and injured patients before participating in the study. Students were organized in five groups while experts were in one group. Each group started to watch the video at the same point (starting with Video 1: before the arrival of the patient). Based on their observations and actions performed in answering to the questions, video 2 or video 3 were switched. If all questions were answered correctly, video 3 would not be played. The prompted questions were discussed in the group and their discussion was collected by the prototype. Through discussion, participants reflected over the right answers. The interactive 360° video gives the participant a direct feedback if the answer was right or wrong. If they answer was wrong the video 1 jumps to the sequence with the unstable patient (video 2), and if they answer right the video 2 jumps to the sequence with the stabile patient (video 1). Figure 1 above (right side) shows a group of students using the prototype during the course of the study. During this study, a number of different data sets were collected: 1) *Video recordings of the study session;* 2) *Content related questions.* Eleven questions and two reflective texts embedded in

the video were developed in order to assess the student´s knowledge gained while interacting with the prototype. The content of the questions is focused on the patient's treatment and team work; 3) *Prototype questionnaire*. After performing the activity, each group was given a questionnaire to gather data about the *Ease of Use* and *Perceived Usefulness* (Davis, 1989); 4) *Prototype log data.* Interaction data about the activity carried out by the group of medical experts were collected and stored in a database in JSON format.

5. Analysis of the Data and Discussion

In this section, the outcomes of the data collected with the students and the experts are presented. First, we describe the results from the students and afterwards from the medical experts. Based on the analysis of the data collected using the *Ease of Use* and *Perceived Usefulness* questionnaire we developed, the prototype was well received by both the students and the experts. The activity in general was perceived as good (47%) to very good (52%) by the participants and the use of 360° videos was appreciated by most students (94%). The use of the touchscreen was perceived less enjoyable than the rest of the tools (12% reserved, 47% good, and 41% very good) due to some difficulties for people to press specific buttons during the activity. However, answering questions during the video was very well received by all participants despite the previously mentioned issue. 12% of the participants had trouble and 18% had some trouble using the touchscreen. The rest of the participants had few issues (35%) to no issue (35%) using this tool. By looking into the video footage, it is apparent that due to their placement (both left and right of the screen), some participants definitely had some trouble pressing the correct spots. This is an issue due to touchscreens in general and the experience will differ from screen to screen. In general, the participants were pleased to be able to work as a team using the same screen in order to discuss and share knowledge (23% satisfied and 77% very satisfied). Oral feedback and questionnaires show that students would like to have this kind of tool during their education (88%) and that it is a good addition to the existing tools to practice. The group activity was also preferred as the participants were able to discuss during it depending on their specialty (77%). It was mentioned several times that being able to be an observer and an actor through answering the question at the same time was very appreciated. The video itself provided a good (35%) to very good (41%) view at specific elements, action, or person in the scene. In general, participants found that the 360° videos were a good way to see how a team of medical expert work in an emergency situation at the hospital. The answers from the expert group were very similar to the one from the students. They would have liked to have such a tool in their education and think that this will be a good addition to the existing teaching methods currently provided. When it comes to the *log data* collected by the prototype during the medical expert study session, they have generated 300 interaction events (camera movements and hotspots interactions). The analysis reveals an increase of interactions (navigation within the 360° space) occurring around 12-14 seconds within the video, where the patient arrives to the emergency room. By analyzing the camera data (pitch and yaw values) occurring between 12-14 seconds, it was clear that users were navigating the 360° video from the patient to the status monitor and looking at the emergency team. The second point in time showing the increase of interaction happened between the timeline 60-65 seconds in the video. There, the emergency nurse starts to describe the health status of the patient. The navigation was performed towards this emergency nurse. We have also looked at the relation between the pattern of navigation within the content of the 360° space video in relation to how experts replied to the questions. The first question was displayed to the users in the timeline of the video equal to 138 seconds. Based on the camera movements, it is noticeable that most interaction events happened before answering the first question. This fact can be explained as users were familiarizing with the 360° video navigation and looking into the emergency team, patient, and health status monitor locations.

6. Conclusion and Future Work

This paper describes our research efforts connected to the design, development and validation of an interactive 360° video system to support specialist nursing students in the context of emergency

situation. The proposed tool offers groups of students the possibility to experience the emergency room and its medical personnel during the intervention in novel ways. The tool was built for group work with different students having different specialties to mimic the way in which a regular trauma team at a hospital works. A user study was conducted with 17 students and four medical experts in the area. Based on the initial outcomes of the evaluation, the results show that the tool can provide students with novel interaction mechanisms that have positive effects in order to improve their knowledge and skills. The students and experts also claimed that it is a good addition to the current methods and tools used currently in their education and daily practices. In future developments, the improvement of the sound recording will be a priority. The addition of more questions and more videos will allow a broader range of interaction. The interface of the tool will also be redesigned to provide an easier and clearer way to interact with it. Another line of development and research is to adapt the existing content to portable Virtual Reality headset such as Oculus rift and the like. The technical features of the system are built already for such transition between devices. Additional studies will be conducted in order to analyze the learnability of the proposed system at a bigger scale. As of now, preliminary results are encouraging, but are yet to be further validated in order to refine both the pedagogical and technical aspects of our approach. Other emergency services have been reporting their interest in such projects and this tool could be used by others such as Police departments and Fire Fighters departments. In the near future, we also plan to further develop all those aspects connected to learning analytics in order to make sense and exploit all the amount of data that is collected during the different learning sessions.

References

Crosling, G. & Webb, G. (2002). Supporting Student Learning: Case Studies, Experience and Practice from Higher Education. London.

Davis, F. D. (1989). Perceived Usefulness, Perceived Ease of Use, and User Acceptance of Information Technology. *MIS Quarterly, vol. 13*, no. 3, pp. 319-340.

De Leng, B.A., Dolmans, D.H., Van de Wiel, M.W., Muijtjens, A.M.M. and Van Der Vleuten, C.P., (2007). How video cases should be used as authentic stimuli in problem-based medical education. *Medical education*, *41*(2), pp.181-188.

Del Blanco, Á., Torrente, J., Fernández-Manjón, B., Ruiz, P., & Giner, M. (2017). Using a videogame to facilitate nursing and medical students' first visit to the operating theatre. A randomized controlled trial. *Nurse Education Today*, *55*(65353263), 45-53.

Elmqvist, C. & Österberg, S.A. (2014). Emergency trauma care- at the scene of an accident and at the emergency department. *Lund: Studentlitteratur.*

Lateef, F., (2010). Simulation-based learning: Just like the real thing. *Journal of Emergencies, Trauma and Shock*, *3*(4), p.348-352.

Medical Realities. (2018). Learn surgery in virtual reality. *Medical Realities*. Retrieved from: www.medicalrealities.com/.

Nayar, S. K. (1997). Omnidirectional video camera. *Proc. DARPA Image Understanding Workshop*, *1*(May), 235–242. Retrieved from http://citeseerx.ist.psu.edu/viewdoc/download?doi=10.1.1.30.6223&rep=rep1&type=pdf.

Parisi, T. (2015). Learning virtual reality: developing immersive experiences and applications for desktop, web, and mobile. O'Reilly Media, Inc.

Persson., M., Uppstu., T., Björnstig, J., Saveman, B. (2014). Utbildning i trauma- och katastrofmedicinsk vård, Kunskapscentrum för Katastrofmedicin (KCKM), Umeå University.

Romero, C., Ventura, S., Gibaja, E. L., Hervás, C., & Romero, F. (2006). Web-based adaptive training simulator system for cardiac life support. *Artificial Intelligence in Medicine*, *38*(1), 67-78.

Spikol, D., Milrad, M., Maldonado, H., & Pea, R. (2009). Integrating co-design practices into the development of mobile science collaboratories. In *Proceedings of IEEE Advanced Learning Technologies (ICALT 2009) Ninth IEEE International Conference* on (pp. 393-397). IEEE Press.

SweTrau. (2014). *Swedish yearly report about trauma registering*. Retrieved from RC SYD website: rcsyd.se/swetrau/wp-content/uploads/sites/10/2015/10/%C3%85rsrapport-SweTrau-2014_SKL.pdf.