A digital twin of the medical simulation lab to improve communication skills of medical doctors. Simulation training in Virtual Reality

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Abstract

The Award-Winning Digital Twin of the Simulation Lab at KU Leuven creates a Multi-User Virtual Reality simulation experience for training communication in medical emergency settings. MICT and ITEC, both imec research groups in Belgium, are investigating the effect of nudging as a scaffolding approach to improve collaborative problem solving. Next, the project is developing a dashboard to be used for debriefing based on multimodal analytics. Our solution meets the challenge of future classrooms crossing the borders of the university creating flexible and unlimited learning opportunities.

1 About your submission

In the context of imec's Smart Education program two Flemish research groups located in Belgium (i.e. itec, KU Leuven and MICT, Ghent University) are working together to create a virtual twin of the university skills lab to create extend the classroom of the future and create flexible and unlimited learning opportunities for skill improvement. The project started in October 2021 and currently a first solution is ready and has been tested, but further Research & Development is ongoing.

As made visible in the video (see: https://www.youtube.com/watch?v=4r0GmqlkiLc) based on multi-user virtual reality, a virtual twin of the simulation lab has been created to train medical diagnosis. More specific, students are confronted with a virtual patient with specific symptoms who needs to be treated following the standard procedures for dealing with emergency care: ABCDE (Airways, Breathing, Circulation, Disability, Exposure). To find the correct diagnose, students need to interact with each other for which they depend on both their problem-solving skills as well as their communication skills. While interacting with the patient, conducting minimal operations (e.g. blood

pressure, saturation…), viewing and interpreting observations and measurements together and communicating with each other students should find that correct solution of this case, i.e. “In-stable angora”.

Based on multimodel learning analytics, we study indicators of joint attention and mutual awareness of the situation during collaborative problem solving. All students’ actions are mirrored on a teacher/trainer dashboard (see pictures). Through the dashboard the teacher/trainer can launch nudges to prompt students to perform certain actions. The current research project is investigating the effectiveness of different nudges (implement versus explicit nudges on the desired behavior). Once we know more about the effectiveness of the nudges, they will be automated.

This solution can create a lot of impact as in emergency situations effective collaboration is critical, e.g. performing cardio-pulmonary resuscitation (CPR). Based on theory and practice, it is known that Collaborative Problem Solving (CPS) involves mutual awareness of the situation, clear communication and joint coordination of work. Poor collaboration wastes valuable time and can ultimately lead to life threatening mistakes. We also know that CPS skills do not come naturally, which means that they need to be trained. In training CPS skills, reliable and valid data about trainee behavior is needed to inform and to provide actionable feedback. Effective feedback is just-in-time (aimed at trainees) and consolidated in debriefing (trainees and trainer). Current solutions rely on fully manual analysis, e.g. (video) observation. This is all very time consuming. Consequently, students often do not get enough opportunities to practice the critical communication and collaborative problem solving skills.

What makes our project unique is that we are working towards automated collaborative practice and analysis in virtual reality. Currently, students get only limited opportunities to practice collaborative problem solving, with our solution, we will be able to offer them much more practice sessions. The virtual twin offers students the same scene as in reality but we can add just-in-time feedback by collecting reliable and valid data about trainee behavior. Collaboration is central in this virtual reality scene, students have to work together during the medical simulation. Both students treat the patient: they can ask questions, they can check parameters and can perform minor medical procedures. By collaborating and communicating efficiently with the patient and each other, the necessary steps to treat the patient can be taken after the right diagnosis was made.

The project is ongoing, we have currently tested the application with 34 students and the first results are promising. The potential can be found in three areas of interest: simulation XR, capture behavior and collaborative problem solving. Students will be able to get independent practice in XR with nudging leading them towards certain desired behaviors. They will also get insight into their own behavior thanks to the debriefing that will be based on authentic data. Trainers get insights into effective guiding practice, they can understand student behavior better and they can establish a well-rounded training programme for each student.

Our VR-enabled classroom sets us on the path to answer the following questions: (i) how are CPS skills visible in observable communicative behaviour? The following actions are captured:

- Visual and auditive contact with the patient
- Visual and auditive contact with the colleague (nurse/doctor)
- Movement
- Position data: proximity to the patient, to peer, to tools…

(ii) What is desired behaviour in CPS and how is this visible in observable behaviour?

(iii) How can we measure this behaviour through advanced software and hardware sensors, ideally in real-time?

The following tracking and detection approaches are used:

- Eye-tracking
- Face-tracking
- Speech detection

(iv) how do we visualize CPS performance to learners so that they can reflect on and learn from their performance (delayed visualization) or can amend their behaviour immediately (real-time visualization)? and (v) how do we alert teachers of individual/group desired or undesired behavioural patterns, so that they can provide appropriate feedback and support to the learners?

Our digital twin created a classroom crossing the boarders of the institution facilitating collaborative learning and multi-insitution education to broaden the international reach.

We hope we can further inspire other institutions in the EUNIS community.

2 Testimonials

2.1 Testimonials from the medical students who tested the simulation in Virtual Reality:

"I found the experience very positive, I am looking forward to using it more frequently in the future. I had less stress in virtual reality than during the regular simulations, I have no clue how it came. I hope we can practice more!"

"I think this can become a very valuable tool for the medical training .You also need less material, I would do this more often if possible."

"I enjoy the virtual reality scene, you feel like it's more real. Even more than with the regular simulator doll. At least, that's my opinion."

"I think it gives us great learning opportunities. You learn by doing and by getting feedback, which is normally not often possible. It also offers us learning opportunities to practice our communication skills with the patient."

2.2 Testimonials from the teachers in medical simulation training:

"Students behave like they would behave with a real patient, I was surprised how immersed they were into the scenario."

"There are great opportunities for the future, it will be very beneficial for students to get more opportunities to practice without our assistance."

3 References / Citations

IMEC Research Group (2022) **:** Collaboration tutor: medical emergency training in extended reality https://www.youtube.com/watch?v=4r0GmqlkiLc

4 Author biographies

Kim works as educational research assistant at itec and is specialized in virtual reality training. She worked on COSMO (Cognitive Support in Manufacturing Operations) where she supported schools to establish digital transformation of learning and teaching with Augmented Reality and Virtual Reality. Kim is part of the BHC21-project (Boosting Human Capital in the 21st Century) where she maps out training programmes and guides companies and training centers to optimize their programmes by including innovative learning technologies. She is also part of the Smart Collaboration Assistant-team, working on a collaborative Virtual Reality environment to train communication skills with medical and nursing students.

Charlotte Vanroelen is a creative developer who focuses on AR- and VR development. She is currently responsible for the setup and development of the ExperienceDNA framework and is guiding the ongoing VR projects into a more structured approach. Projects she's helped set up include the simulation training in Virtual Reality with ITEC and the ergonomic Valence project with VUB's Brubotics team. Previous work of hers can be found in various museums and visitor centers in Belgium. Charlotte has a Bachelor's degree in Digital Arts & Entertainment (2012, Hogeschool West-Vlaanderen) and a second one in Digital Design & Development (2016, Hogeschool West-Vlaanderen). She also obtained a postgraduate teaching degree in 2016 which she uses to teach a new generation of creatives at LUCA.