**Immersive learning: Way forward in chemical engineering education and operator training?**

Jarka Glassey1, Daniel Cermak-Sassenrath2, Jean-Luc Dubois3, Kevin Haelterman4, Liesbeth Kester5, Thies Pfeiffer6, Michael Wilk7, Tom van Gerven8

*1School of Eng., Newcastle Uni, UK; 2Center for Computer Games Research, IT Uni Copenhagen, 3HR Dept, Arkema, 4LuGus Studios, 5Dept. of Education, Uni Utrecht, 6Centre of Excellence for Cognitive Interaction Tech, Bielefeld Uni, 7Performance Materials Operations Organics, Merk, 8Dept of Chem Eng, KU Leuven*

*\*Corresponding author: Jarka.glassey@ncl.ac.uk*

**Highlights**

* Benefits of immersive learning technologies in chemical engineering education highlighted.
* Overview of current attitudes to safety training provided.
* Challenges in measuring learning gain through these approaches discussed.

**1. Introduction**

Chemical engineering education is influenced not only by the significant changes in the process industries, including Industry 4.0 concept, but also in rapidly changing educational experiences and expectations of the future chemical engineers. A 2016 survey by Hanover Research and McGraw Hill Education shows that 84% of college students report that the use of technology improves their education, 81% report that digital learning technology helps save them time and be more efficient, and 81% claim that digital-learning technology is helping them boost their grades [1].

Digital game-based learning is an excellent tool to teach conceptual and procedural knowledge and competences in an interactive and participative manner, hence complementing conventional teaching methods in the acquisition of experience in meta-level thinking, on-going learning and constructive problem solving [2]. Digital games contribute to the intrinsic motivation of the student to learn; they appeal to intuition to learn complex and abstract concepts; and the methods that are applied are considered to be very relevant by the population under the age of 25, who are growing up in a digital and mediatized environment. Virtual reality (VR) technology increases implementation efficiency, as the interactive learning material is of a digital nature and can thus be distributed to (teams of) trainees more efficiently than physical training installations.

This contribution reports on a subset of activities of an MCSA ETN Charming, which addresses this challenge by developing learning strategies, content and prototypes for the application of games and VR/augmented reality (AR) for motivating, teaching and training children, students and employees in chemistry, chemical engineering and chemical operations (Fig 1). In particular, this contribution sets out to explore the benefits of games, VR and immersive learning in safety teaching and operator training. This research builds on the results of an EIT Raw Materials sponsored project, which explored the use of gaming in engaging young pupils in concepts of recycling and thus encouraging them into chemical engineering careers. The learnings from this project were invaluable in the development and the evaluation of the work reported here.



**Figure 1.** Motivation, Teaching and Training in the Updated and Extended Cognitive Load Model (adapted from [3]).

**2. Methods**

Review of current literature and case studies on the use of VR/AR in tertiary education and continuous professional development (CPD), together with latest developments in psychology, e.g. in the field of situational judgement, facilitated the development of the questionnaires to establish the current attitudes of students/operators to the use of technology for safety training. Statistical analysis of numerical responses, together with the thematic analysis of open text responses provides the starting point for the development of the VR/AR based safety training system.

**3. Results and discussion**

The previously mentioned research on gaming in inspiring young generation of chemical engineers by engaging them a highly topical area of recycling of various materials indicated high levels of engagement in an appropriately designed virtual environment can be achieved. With the technology savvy generation of University students and early stage professionals, this is a useful approach to engaging the professionals with the aim of increasing retention of knowledge. The analysis of industrial case studies using technology enabled safety training indicate positive impact of technology on retention of important concepts.

**4. Conclusions**

The VR training environment can present content for learning in new ways, thus providing grounds for creativity and innovation of new learning technologies based on an available platform. Simulation-based immersive VR training allows the trainees to explore the use of the simulated systems freely, learning about the effects and consequences, which provides them with more flexibility and deeper learning than case-based learning. This is particularly important in the highly ‘risk averse’ industry, such as the chemicals sector, where innovation is often stifled by (frequently overestimated) fear of safety issues associated with particular solutions. The results of the questionnaire analyses to establish current attitudes to technology enabled safety training will be presented. The challenges in measuring learning gain through these approaches will by highlighted in the context of these results and initial methodology of VR/AR enable training framework will be highlighted.

**References [Calibri 10]**

1. Hanover Research and McGraw Hill Education (2016). Digital study trends survey. https://learn.mheducation.com/edtech\_digital\_study\_trends.html
2. C.I. Muntean, Proc. 6th Int. Conf. Virtual Learning ICVL, 2011, 323-329;
3. H.H. Choi, J.J.G. van Merrienboer, F. Paas, Educational Psychology Review, 26 (2014), 225–244