Health Education England

Literature Search Results: Innovative technologies in healthcare science education

Research question or topic: Evidence review on the use of emerging innovative technologies (Virtual Reality, Extended Reality and Augmented Reality) and simulation in the delivery of healthcare science education (theory and practice)
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Completed by: HEE Knowledge Management Team (Jo McCrossan)
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Please acknowledge this work in any resulting paper or presentation as: Literature Search: Innovative technologies in healthcare science education. Jo McCrossan. (07/04/2021). UK: Health Education England Knowledge Management Team
Search reference number (internal): 443

Contents

Search comments

The literature includes examples of the use of innovative technologies in educational settings n the following fields:

- Biomedical sciences **[1, 6]**
- Medical physics **[2, 5]**
- Genetics **[3]**
- Audiology **[4]**
- Radiology **[7, 8, 9]**
- Urology **[10]**
- Imaging **[11]**

Complete numbered list of results with links

Number	Citation	Abstract/ key themes
1	Immersive virtual reality for supporting complex scientific knowledge: Augmenting our understanding with physiological monitoring M. Lui, et al. British Journal of Educational Technology; Nov 2020; vol. 51 (no. 6); p. 2180-2198 *Abstract only**	In this study, an IVR simulation of a complex gene regulation system was co - designed with an undergraduate microbiology course instructor. We found that students who were seated while in IVR demonstrated significantly higher conceptual understanding of gene regulation at the end of the course and higher overall course outcomes, as compared to students who experienced the course as originally designed (control). However, students who experienced IVR in a standing position performed similarly to the control group. In addition, learning gain appears to be influenced by a combination of prior knowledge and how IVR is experienced (ie, sitting vs. standing). Learning implications for the connections between sensorimotor systems and cognition in IVR are discussed.
2	Effects of augmented reality on learning and cognitive load in university physics laboratory courses M. Thees, et al. Computers in Human Behavior; Jul 2020; vol. 108 *Athens log in required**	In summary, AR poses useful features to realize instructional design principles, but addressing crucial points of learning processes is not guaranteed per se. **Highlights** • Development and investigation of AR-based physics laboratory scenario. • Application of spatial and temporal contiguity to avoid split-attention. • Adaptation of self-reported cognitive load scale for laboratory course instructions. • Significant reduction of extraneous load for AR-based workflow. • No significant group-dependent learning gains for conceptual knowledge.
3	Investigating the feasibility of using assessment and explanatory feedback in desktop virtual reality simulations G. Makransky, et al. Educational Technology Research and Development; Feb 2020; vol. 68 (no. 1); p. 293-317	In this study, we investigated the feasibility of developing a desktop virtual reality (VR) laboratory simulation on the topic of genetics, with integrated assessment using multiple choice questions based on item response theory (IRT) and feedback based on the cognitive theory of multimedia learning. The results showed that assessment items in the form of gamified MC questions were perceived by most students to lead to higher levels of understanding and did not lead to lack of motivation. Items within a simulation were found to fit the partial credit model (PCM), illustrating that IRT can be a viable methodology for

	*Athens log in required**	accurate assessment with a desktop VR simulated environment. Finally, results showed that the sample had a small significant increase in intrinsic motivation and self-efficacy, and a large significant increase in transfer, following the genetics simulation. These results suggest that it is possible to develop online educational material that retains the relevance and connectedness traditionally associated with informal assessment, while simultaneously serving the communicative and credibility-based functions traditionally associated with formal assessment. See also: Investigating the process of learning with desktop virtual reality: A structural equation modeling approach [abstract only]; Equivalence of using a desktop virtual reality science simulation at home and in class
4	Training outcomes for audiology students using virtual reality or traditional training methods D. Bakhos, et al. PloS one; 2020; vol. 15 (no. 12); p. e0243380 *Athens log in required**	Our immersive VR training system provided audiology students with better learning outcomes and self-confidence than found with traditional training. Presently, the VR simulator can be used as a supplement to traditional audiology training; additional studies are needed to know whether it can replace traditional training. Further technological developments are also needed to expand the audiology training modules, such as behavioral and objective hearing tests for pediatric patients.
5	Developing a contextualised blended learning framework to enhance medical physics student learning and engagement I. Czaplinski, & A. L.Fielding Physica medica: PM : an international journal devoted to the applications of physics to medicine and biology : official journal of the Italian Association of Biomedical Physics (AIFB); Apr 2020; vol. 72 ; p. 22-29 *Athens log in required**	The Radiotherapy Physics unit in a Masters level Medical Physics course of study was re-designed to increase active learning that included scaffolded in-class and online tasks and supported by virtual reality simulations. **Highlights** • Blended Learning framework implemented into a postgraduate Medical Physics course. • Framework included the Virtual Radiotherapy Environment (VERT). • Greater emphasis on real world medical physics learning experiences. • Short high-quality online videos of clinical medical physics procedures were used. • Students understanding of effective learning strategies found to need improvement.

6	Utilising Anatomical and Physiological Visualisations to Enhance the Face-to-Face Student Learning Experience in Biomedical Sciences and Medicine C. Moro, & S. Gregory Advances in experimental medicine and biology; 2019; vol. 1156 ; p. 41-48 *Athens log in required**	While technology has been increasingly utilised by universities to facilitate off-campus learning in the past, recent years have seen its introduction into on-campus learning experiences. This has created not only the ability for educators to provide structured, modern and individualised sessions, but also allowed students alternative ways to learn during teacher-directed sessions. This has included the introduction of virtual, augmented and mixed reality to the anatomy and physiology labs, as well as 3D printing, and even virtual dissections through interactive tables and screens. This use of educational technology within the laboratory or learning sessions is the start of an exciting time, where students are likely to be taught not solely by a single academic, but through a mixture of real-life and virtual modes of learning, all working concurrently to provide a modern, interactive learning experience.
7	Implementing Virtual and Augmented Reality Tools for Radiology Education and Training, Communication, and Clinical Care R. N. Uppot, et al. Radiology; Jun 2019; vol. 291 (no. 3); p. 570-580 *Athens log in required**	The benefits, as identified by Dalgarno and Lee (25), of VR for education include the following: (a) The ability to experience a 3D conceptual model of a physical environment, (b) facilitating experiential learning that would be difficult or impractical to undertake in the real world (26), and (c) improved transfer of knowledge and collaboration with other learners. […] AR provides an opportunity for educating trainees and engaging patients (5,27). Early studies of AR have shown improvements in student motivation for learning, in interactivity, and in the learning of material (27–29). The successes of AR for education are thought to be related to the novel experience and the preserved ability for interaction given that the material is superimposed on a real-world background. AR has been used within the field of radiology to help trainees conceptualize complex anatomy. For example, AR is used in training radiology residents to understand inner ear anatomy.
8	3D virtual reality simulation in radiography education: The students' experience M. O'Connor, et al. Radiography (London, England: 1995); Feb 2021; vol. 27 (no. 1); p. 208-214	In this study, an immersive three-dimensional (3D) virtual radiography simulation tool was piloted in an undergraduate Radiography curriculum and user feedback retrieved. 3D immersive VR simulation is perceived by radiography students to be a valuable learning resource. VR needs to be strategically implemented into curricula to maximise its benefits. Students felt more confident in their radiographic technique after using the tool and thoroughly enjoyed this interactive learning experience. However, it should

	*Athens log in required**	be noted that VR was deemed a useful learning resource to supplement, not replace, existing clinical skills labs and clinical placement.
9	The use of virtual reality computed tomography simulation within a medical imaging and a radiation therapy undergraduate programme T. Gunn, et al. Journal of medical radiation sciences; Mar 2021; vol. 68 (no. 1); p. 28-36 *Athens log in required**	This study aimed to measure MRS student confidence in performing a CT scan in the clinical environment after using VR CT Sim as a learning tool. The overall result from both studies was that students agreed that access to this simulation was beneficial to their clinical CT confidence. The importance of safe practice in a low - pressure environment as reported in the literature is all critical findings that can have the potential to improve clinical confidence.
10	Review of the effect of 3D medical printing and virtual reality on urology training with 'MedTRain3DModsim' Erasmus + European Union Project I. Tatar, et al. Turkish journal of medical sciences; Oct 2019; vol. 49 (no. 5); p. 1257-1270 *Athens log in required**	The MedTRain3DModsim Project aimed to produce 3-dimensional (3D) medical printed models, simulations, and innovative applications for every level of medical training using novel worldwide technologies. It was aimed herein to improve the interdisciplinary and transnational approaches, and accumulate existing experience for medical education, postgraduate studies, and specialty training.
11	Simulation of Image-Guided Intervention in Medical Imaging Education L. F. N. D. Carramate, et al. Journal of medical imaging and radiation sciences; Jun 2020; vol. 51 (no. 2); p. 235-240 *Abstract only**	In this work, a learning experience, consisting of simulating a pacemaker implantation, implemented over 3 years with students pursuing the Medical Imaging and Radiotherapy degree at the University of Aveiro was evaluated. Students considered this experience valuable for their education, strongly agreeing that the simulation environment helped their learning process and allowed them to acquire, consolidate, and deepen knowledge. Furthermore, they considered that it impressed on them the necessity to continue to improve their learning, and that they would like to participate in other simulation scenarios. This simulation activity was a valuable experience for the learning process of the students because it facilitated the acquisition and consolidation of knowledge. It also allowed the students to be aware of the importance of being engaged in

		their own education. The results were highly consistent over the 3 years, reinforcing the positive feedback from this experience.

Appendix

Sources and Databases Searched

Healthcare Databases Advanced Search (HDAS) was used to search the following databases: AMED; Medline; CINAHL; BNI; EMBASE; EMCARE; PubMed; HMIC and PsycINFO. Google Scholar was used to citation match and find further relevant papers.

Search Strategies

1. “virtual reality” OR VR
2. “extended reality” OR XR
3. “mixed reality” OR MR
4. “augmented reality” OR AR
5. “clinical simulation” OR “medical simulation” OR “health simulation”
6. tech* AND (immersive OR innovative OR emerging)
7. ("clinical bioinformatics" OR "genomics" OR "clinical scientist" OR "patholog*" OR "genetics" OR "reproductive science" OR "analytical toxicolog*" OR "anatomical patholog*" OR "biomedical science" OR "blood science" OR "cancer genomics" OR "cellular science" OR "clinical biochemist*" OR "clinical immunolog*" OR "cytopatholog*" OR "genomic counselling" OR "genomics" OR "haematolog*" OR "hematolog*" OR "histocompatibility" OR "immunogenetics" OR "histopatholog*" OR "infection science" OR "microbiolog*" OR "androlog*" OR "virology" OR "health informatics" OR "medical physics" OR "clinical engineering" OR "clinical measurement" OR "clinical pharmaceutical science" OR "clinical photograph*" OR "sterile services" OR "imaging" OR "medical device risk management" OR "medical engineering" OR "nuclear medicine" OR "radiation physics" OR "radiotherapy physics" OR "reconstructive science" OR "rehabilitation engineering" OR "renal technolog*" OR "audiolog*" OR "cardiac science" OR "clinical perfusion" OR "critical care science" OR "gastrointestinal physiology" OR "neurophysiology" OR "ophthalmic science" OR "vision science" OR "respiratory physiology*" OR "sleep science" OR "urodynamic science" OR "vascular science")
8. ("healthcare science" OR "healthcare scientist" OR "health care scien*")
9. (education OR training OR learning)
10. 1 OR 2 OR 3 OR 4 OR 5 OR 6
11. 7 OR 8
12. 10 AND 11

Disclaimer

Searching the literature retrieved the information provided. We recommend checking the relevance and critically appraising the information contained within when applying to your own decisions, as we cannot accept responsibility for actions taken based on it. Every effort has been made to ensure that the information supplied is accurate, current and complete, however for various reasons it may not represent the entire body of information available.

*Help accessing article or papers

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