NHS
Health Education England

Literature Search Results: Innovative technologies in pharmacy education

Research question or topic: Pharmacy Ed - evidence review on the use of emerging innovative technologies (Virtual Reality, Extended Reality and Augmented Reality) and simulation in the delivery of pharmacy education (theory and practice)
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Please acknowledge this work in any resulting paper or presentation as: Evidence/ Literature Search: Innovative technologies in pharmacy education. Jo McCrossan. (19/03/2021). UK: Health Education England Knowledge Management Team

Contents

Search comments and headlines

Due to the developing nature of the topic, the search focused on literature published since 2018 – with one exception ([17], dated 2014) included in the results. It identified a number of examples of applications of innovative technologies in the field of pharmacy education, particularly in terms of its impact in an educational setting; its implications for the pharmacy workforce; and its contribution to interprofessional education.

Training

The role of virtual and augmented reality in pharmacy education receives particular attention in the literature, and the benefits of using simulation to provide immersive, interactive learning scenarios without compromising patient safety are highlighted [1, 3, 4]. However, it is recognised that the use of such technologies may also present a number of challenges, particularly in terms of cost, accessibility, and usability. User receptiveness is also identified as a key factor that should influence the use of immersive technologies as educational tools within the pharmacy curriculum: for example, several studies found that students valued and were engaged by the simulation sessions they experienced as part of their training [5, 6, 7, 8, 10, 11], with one study [6] emphasising the importance of maximising learning outcomes and focusing on students' learning needs when delivering education.

Workforce

The potential of "health information technology" to improve patient care by supporting pharmacy students to become more confident, competent practitioners is discussed [14, 15]. Immersive technologies may also prove useful in engaging the pharmacy students of the future, and in diversifying the workforce – for example, by involving high school students in innovative, real-world research [13].

Interprofessional education

Immersive technologies can be used to support the development of collaborative skills, and enable pharmacists to become more effective members of interprofessional teams [19]. Early exposure to team care through IPE virtual reality simulation can foster understandings of the interdependent roles of health care professionals toward patient-centred care [16, 17, 18].

Complete numbered list of results with links

Training

Number	Citation	Abstract/key themes
1	The “Warrior” system: a new useful emergency simulator to train clinical pharmacists in emergency medicine C. Huang, et al. *Athens log-in required**	The implementation of the “Warrior” emergency treatment system was very successful. In the training of clinical pharmacists, it provides a rich and realistic clinical experience and improves the teaching effect. The system development continues, since many modules are currently imperfect, including the endocrine and coagulation systems. Furthermore, drugs are presently administered via intravenous injections and intravenous drips, but oral drug systems will also be developed in the future. Moreover, the influence of drug interactions, which are important data for the work of clinical pharmacists, will be developed. Simultaneously, we will create more clinical cases and presentations, so that students can obtain greater clinical experience. Since the Warrior system has just begun to use, so the sample size was small, we will continue to promote it in the training of clinical pharmacists, we will do wider research, and provide research support to improve the improvement of the “Warrior” system. Briefly, the “Warrior” emergency simulator system provides a good training path for clinical pharmacists; some achievements have already been made, and the system will acquire more features in the future.
2	Human-Centered Work: How Pharma Can Move to a Blame-Free Culture A. Shanley Pharmaceutical Technology Europe; Jan 2020; vol. 32 (no. 1); p. 20-21 *Athens log-in required**	The article discusses importance of simplifying procedures and training in pharmaceuticals industries to prevent costly morale, quality, and compliance problems. Topics discussed include information on need for focus on training, testing, and auditing for pharmaceutical and medical device companies; rising mergers and acquisitions in pharmaceutical industry; and role for virtual and augmented reality, in setting up risk-free learning environments.
3	Virtual Reality in Pharmacy: Opportunities for Clinical, Research, and Educational Applications C. Lee Ventola	[Abstract] Virtual reality (VR) has been widely studied and applied in numerous medical applications. In pharmacy, VR can potentially be applied as follows: adjunctively or as a replacement for pharmacotherapy; in drug design and discovery; in pharmacist education; and in patient counseling and behavior

	P&T: A Peer-Reviewed Journal for Managed Care & Formulary Management; May 2019; vol. 44 (no. 5); p. 267-276 *Abstract only**	modification. Research applying VR in pharmacy is currently limited; however, interest in these applications is increasing. The majority of studies conducted during the past decade have found VR to be safe and effective, and to promote a high degree of user satisfaction. VR technology has become increasingly affordable, flexible, and portable, enabling its use for therapeutic purposes in both inpatient and outpatient environments. But despite the compelling features of VR, a number of challenges exist, such as validation of clinical efficacy, cost/accessibility and usability issues, technical capabilities, and acceptance. This article discusses the potential for the use of VR in pharmacy for clinical, research, and educational applications.
4	The Past, Present, and Future of Virtual Reality in Pharmacy Education L. Coyne, et al. American Journal of Pharmaceutical Education; Mar 2019; vol. 83 (no. 3); p. 281-290 *Athens log-in required**	Earlier versions of VR have been used to provide pharmacy students with active-learning opportunities for many years. However, until recently technology has been restricted to two-dimensional computer screens, expensive simulation mannequins, and static paper-based cases. The latest VR technology involves head-mounted displays that provide interactive 360o environments. This is a crucial step forward in the utility of VR for pharmacy education, as the 360º environment allows for experiences that can immerse the learner in active learning scenarios that would not be otherwise possible. […] Virtual reality environments could be used to provide high-fidelity pharmacy simulations, field trips through the human body, and even opportunities to learn from mistakes, which is usually not feasible with real patients. The full extent to which VR will be used in the pharmacy curriculum is not yet clear and dependent on the development of appropriate software, but early opportunities may involve experiential and laboratory simulation. Widespread adoption of VR for use in pharmacy education will be dependent on overcoming comfort issues, high cost, and the limited educational content available. With more research and development, particularly software development, VR has the potential to become an integral part of pharmacy education.
5	[Abstract] Pharmacy students' receptiveness of virtual reality and perception of its impact on curriculum P. Carcamo, et al.	**Introduction:** Virtual reality (VR) uses advanced technology to create an immersive, interactive, and hands-on experience. Published research has demonstrated that the use of VR in the classroom may enhance academic achievement by increasing learner engagement; however, the literature did not include pharmacy students. Understanding pharmacy student receptiveness and acceptance of VR is important to understand how to incorporate to maximize impact.

	JACCP Journal of the American College of Clinical Pharmacy; 2020; vol. 3 (no. 8); p. 1564 *Abstract only**	**Research Question or Hypothesis:** To determine pharmacy student receptiveness and acceptance of VR as an educational tool within the pharmacy curriculum. Study Design: Cross-sectional study utilizing matched response analyses for pre and post exposure. **Method(s):** The survey was administered to all first-year pharmacy students (n = 95) enrolled at the University of South Florida Taneja College of Pharmacy. Qualtrics was used to administer the pre/post surveys with rating scale questions, students were emailed the link to complete. The six-question pre-survey measured students' baseline understanding of beta-blockers, familiarity, perceptions, and understanding of VR. The nine-question post-survey assessed the level of receptiveness, perceived engagement, and utility of the VR activity. Descriptive statistics, Pearson correlation and matched analyses were undertaken. **Result(s):** A total of 45 pre-activity (47% response rate) and 22 postactivity surveys (23% response rate) were completed. Eighty-six percent (86%) of participants either agreed or strongly agreed that they would be interested in having more VR sessions in the classroom and 82% would recommend the use of VR to other pharmacy students. Overall, 50% of participants responded that VR enhanced their learning and understanding, while no students indicated a worsening of learning or understanding. A significant negative correlation was observed between self-reported technology proficiency and comfort with VR, suggesting a need for additional training prior to the activity. **Conclusion(s):** Pharmacy students appear receptive to the use of VR in the classroom. Further investigation of the value of VR in pharmacy education should be explored.
6	Online versus classroom learning in pharmacy education: Students' preference and readiness Q. Y. Lean, et al. Pharmacy Education; 2020; vol. 20 ; p. 19-27	**Results:** There was no significant difference between the knowledge scores when comparing online learning and face-to-face learning, suggesting online learning was as effective as the face-to-face learning method. The majority of students reported that they enjoyed online learning and found that online learning was a useful learning tool. Having said that, most students purported a preference for a blended learning approach. The students valued the

	*Athens log-in required**	interaction available in face-to-face learning and the time flexibility offered by online learning. **Conclusion:** Online and face-to-face learning methods were found equally effective for student learning, yet pharmacy students denoted that they favoured a blended learning approach. Although computer and innovative technologies diversify existing teaching and learning methodologies, matching students' learning needs is crucial when selecting the delivery approach to maximise student learning outcomes.
7	Evidence for simulation in pharmacy education A. L. Seybert, et al. JACCP Journal of the American College of Clinical Pharmacy; Dec 2019; vol. 2 (no. 6); p. 686-692 *Abstract only**	…the University of Pittsburgh School of Pharmacy has embraced innovative approaches to learning and documented advancement of clinical pharmacy education. This brief report will discuss advances in national and international pharmacy education, as well as the PittPharmacy experience with simulation education. A particular emphasis is on human patient simulation, computer‐based simulation, virtual patient, and gaming in the settings of direct patient care‐related education and assessment. The available literature and the experience at PittPharmacy shows improvement in learner satisfaction, knowledge enhancement, critical thinking skills, and problem solving in patient care topics. The evidence included provides support for the use of simulation to advance clinical pharmacy education and can serve to encourage further scholarship in this area.
8	Development of a pharmacy critical care elective utilising online case-based patient simulations P. Staffieri, et al. Pharmacy Education; 2019; vol. 19 ; p. 219-221 *Athens log-in required**	A total of 11 out of the 12 students self-reported that the online in-class case format utilising EHR simulation technology improved their problem-solving skills, with one student disagreeing. All students self-reported that their ability to formulate an evidence-based, patient specific pharmacotherapeutic plan had improved, along with their interest in critical care. When asked if EHR simulation technology should be incorporated into other courses in the pharmacy curriculum, nine out of the 12 students agreed, one neutral, and two disagreed.
9	Introducing Augmented Reality Technology to Enhance Learning in Pharmacy Education: A Pilot Study J. Schneider, et al. Pharmacy (Basel, Switzerland); Jun 2020; vol. 8 (no. 3)	AR technology can position the learner within a real-world context whilst enabling participatory learning practices. While the results of this study require further investigation, it is clear that AR technology has the potential to engage and stimulate students in a way that could create a more inclusive learning environment. This study has identified the benefits that AR can bring to tertiary pharmacy education. AR technology can be implemented at minimal cost to the creator and the learner as the vast majority of students own mobile devices.

	*Athens log-in required**	Web-based AR platforms are easy to learn and implement and can provide educators with a simple introduction to the world of augmented and virtual reality technology. Further research is required to investigate the use of AR for learning about a range of different medications and build on the implementation of AR in tertiary pharmacy education.
10	Exploring virtual reality as a platform for distance team-based learning L. Coyne, et al. Currents in pharmacy teaching & learning; Oct 2018; vol. 10 (no. 10); p. 1384-1390 *Abstract only**	Online distance education has become popular in pharmacy education, but it can be challenging to provide engaging experiences such as team-based learning (TBL) in this format. This study explored the utility of virtual reality (VR) as a platform to provide the engaging elements of TBL, without students needing to be physically present in the same room. […] The response of participants to this study was positive and the overall conclusion was that VR has the potential to be a useful tool for online, distance TBL, and should be explored further.
11	Evaluation of Vaccination Training in Pharmacy Curriculum: Preparing Students for Workforce Needs M. Bushell, et al. Pharmacy (Basel, Switzerland); Aug 2020; vol. 8 (no. 3) *Athens log-in required**	Students found value in the use of mixed reality to enhance student understanding of the anatomy of injection sites. […] 2.1.3. Simulation To simulate environments and prepare students for real experience, the training program used the following: role-plays, mannequins, standardized patients, and mixed reality. Students had to role play and administer vaccinations to both a pediatric and adult low fidelity mannequin. A mixed reality simulation technique using the Microsoft Hololens head-mounted devices along with the GIGXR applications Holohuman and Holopatient were used in the face -to-face delivery. The two applications were used to augment the students understanding of anatomy and physiology and to view a simulated patient who was portraying symptoms of anaphylaxis. Holohuman is an anatomy application that allows a student to gain a spatial understanding of anatomy and walk through the holographic body. As the student walks through the holographic image, layers of virtual anatomy peel away to reveal the underlying structures. This provided students with a unique way of identifying landmarks (i.e., deltoid muscle) for intramuscular (IM) vaccination. It was used to enable students to visualize the shoulder (synovial) joint and to recognize why a shoulder injury related to vaccine administration

		(SIRVA) would occur if given too high. Mixed reality has the power to engage the learner in a variety of interactive ways, which until this point have not been possible.
12	Forces driving change in pharmacy education: Opportunities to take academic, social, technological, economic, and political into the future D. H. Rhoney, et al. JACCP Journal of the American College of Clinical Pharmacy; February 2021	These technologies—collectively referred to as XR—have long held promise within education, and while their cost (both to develop content and to deploy widely) remains generally high, their capability keeps expanding. The different realities afford different experiences for the student, but they share a basic approach in allowing a student to express knowledge and demonstrate skills within a realistic simulation. The question is if pharmacy education is ready for these emerging technologies. There is an opportunity to capitalize on the information that has been gained prior to and through the pandemic to create a national level collaboration for creating knowledge‐based resources in different professional education settings.

Workforce

Number	Citation	Abstract/key themes
13	Immersive Research Experiences for High School Students Aimed at Promoting Diversity and Visibility in Pharmacy Education J. E. McLaughlin, et al. American Journal of Pharmaceutical Education; Mar 2020; vol. 84 (no. 3); p. 297-301 *Abstract only**	[Abstract] Two challenges frequently faced by schools of pharmacy are the training of a workforce that reflects the racial and ethnic diversity of the populations they serve, as well as raising public awareness of the mission and impact of pharmacy schools. One underutilized strategy in addressing these challenges is directly engaging high school students, whose race and ethnicity more closely reflect the increasing diversity of the US population, in immersive research experiences at schools of pharmacy. Motivated by the multidisciplinary nature of pharmaceutical sciences that involve integration of various science, technology, engineering, and mathematics (STEM) disciplines, the UNC Eshelman School of Pharmacy created the Young Innovators Program (YIP). The program is an eight-week paid summer internship that immerses participants in cutting-edge and innovative research. Through careful planning, strategic collaboration, and a purposeful recruitment process, we believe pharmacy education could benefit from the expansion of immersive

		programs that promote the engagement of racially and ethnically diverse high school students in real-world research.
14	Assessing performance and engagement on a computer-based education platform for pharmacy practice K. Grindrod, et al. Pharmacy; Mar 2020; vol. 8 (no. 1) *Athens log-in required**	Abstract: A computer-based education platform was developed using a theory-based approach to help Canadian pharmacy professionals adopt their full scope of practice. […] Of the 5290 users, 68% were pharmacists, 11% were technicians, 13% were pharmacy students, and 8% were pharmacy technician students. Four clusters were identified separately for pharmacists and technicians. Clusters with the higher performance and engagement tended to have more users practicing in community pharmacies while the lower performing clusters tended have more internationally trained users. In the regression modelling, pharmacists performed better than technicians and students while students were more engaged ($p < 0.0001$). Further, internationally trained pharmacists had slightly lower scores but similar engagement compared to domestically trained pharmacists ($p < 0.0001$). Users demonstrated higher performance on modules related to scope of practice than on clinical topics, and were most engaged with topics directly impacting daily practice such as influenza vaccinations and new and emerging subjects such as cannabis. The cluster analysis suggests that performance and engagement with a computer-based educational platform in pharmacy may be more related to place of practice than to personal demographic factors such as age or gender.
15	The role of self-efficacy, flexibility, and gender in pharmacy students' health information technology readiness R. J. Jacobs, et al. Currents in Pharmacy Teaching and Learning; Nov 2019; vol. 11 (no. 11); p. 1103-1110 *Abstract only**	With the increased adoption of HIT in pharmacy practice, innovative approaches to HIT education are needed. Curricula that help students overcome obstacles to embracing technology may now be warranted. With enhanced training and engagement involving more than just didactic lessons, pharmacy students may not only feel confident in their ability to embrace HIT in future practice but feel professional satisfaction, increasing the likelihood for improved patient care and health system sustainability.

Interprofessional education

Number	Citation	Abstract/key themes
16	Virtual Reality Simulation in Interprofessional Round Training for Health Care Students: A Qualitative Evaluation Study S. Y. Liaw, et al. Clinical Simulation in Nursing; Aug 2020; vol. 45; p. 42-46 *Abstract only**	[Abstract] Early exposure to team care through IPE virtual reality simulation can foster understandings of the interdependent roles of health care professionals toward patient-centered care. For greater clinical impact, a further recommendation is to supplement with workplace-based team training to contextualize learning with practice settings.
17	Qualitative evaluation of a standardized patient clinical simulation for nurse practitioner and pharmacy students L. Koo, et al. Nurse Education in Practice; Nov 2014; vol. 14 (no. 6); p. 740 *Athens log-in required**	[Abstract] This article describes a qualitative evaluation of an interprofessional educational experience for nurse practitioner and pharmacy students using standardized patients and physicians role-playing physicians in clinical scenarios. Small groups of students and faculty facilitators worked through two clinical scenarios that were based on the expected emergence of the patient-centered medical homes. … Participants expressed improved understanding of individual roles, increased confidence, and a better sense of interprofessional support. The educational experience themes included the benefits of a realistic nature of the simulation and the need for improved student orientation to roles and expectations prior to the clinical simulations.
18	Development and Assessment of an Interprofessional Education Simulation to Promote Collaborative Learning and Practice L. Iverson, et al. Journal of Nursing Education; Jul 2018; vol. 57 (no. 7); p. 426 *Athens log-in required**	Although students expressed some awkwardness in working as a team, most stated that they could use their discipline-specific expertise to aid in the care of the patient, as well as learn and respect the other team member's knowledge and contributions. … Student comments demonstrated the importance that the experience had in recognizing their role in collaborative care: I realized that I could have played my role as a pharmacist better. That is, not only answering the question that was asked of me but also to interpret how they were going to use that information to improve patient care.

19	Preparing Pharmacists for Collaborative/Integrated Health Settings F. J. Ascione Pharmacy; Jun 2019; vol. 7 (no. 2) *Athens log-in required**	[Abstract] Pharmacy practice is changing to accommodate the need for pharmacists to be better team members in newly emerging collaborative care and integrated health systems. […] These curricular decisions should be based on existing and new research on the effectiveness of IPE on student's attitudes, knowledge, skills, and behavior. A key decision is how to create effective interactions between pharmacy students and those of other professions. Educational emphasis should be directed toward team building skills, not just individual competencies. The pharmacy faculty probably need to enhance their teaching abilities to accommodate this change, such as learning new technology (e.g., simulations, managing online exchanges) and demonstrating a willingness to teach students from other professions.

Other applications

Number	Citation	Abstract/key themes
20	Establishing clinical pharmacist telehealth services during the COVID-19 pandemic E. M. Segal, et al. American Journal of Health-System Pharmacy; Sep 2020; vol. 77 (no. 17); p. 1403-1408 *Abstract only**	[Abstract] In this article, we highlight our process of expediting the implementation of telehealth services. This process included obtaining authorization for the credentialed pharmacists to provide telehealth services, completion of training modules, implementation of new technology platforms, development of new workflows, and utilization of resources for providers and patients to facilitate successful completion of telehealth visits. We also highlight the consent and documentation components crucially important to the telehealth visit and share some of our successes, as well as identified limitations, in providing pharmacist services via telehealth.
21	Emerging Pharmacotherapy and Health Care Needs of Patients in the Age of Artificial Intelligence and Digitalization B. J. Zarowitz Annals of Pharmacotherapy, Oct 2020; vol. 54 (no. 10); p. 1038-1046	[Abstract] Advances in the application of artificial intelligence, digitization, technology, iCloud computing, and wearable devices in health care predict an exciting future for health care professionals and our patients. Projections suggest an older, generally healthier, better-informed but financially less secure patient population of wider cultural and ethnic diversity that live throughout the United States. A pragmatic yet structured approach is recommended to prepare health care professionals and patients for emerging pharmacotherapy needs. Clinician training should include genomics, cloud computing, use of large data sets,

	*Athens log in required**	implementation science, and cultural competence. Patients will need support for wearable devices and reassurance regarding digital medicine.
22	More than coffee – a World Café to explore enablers of pharmacy practice research O. Kavanagh, et al. International Journal of Pharmacy Practice; Oct 2020; vol. 28 (no. 5); p. 512-521 *Abstract only**	[Abstract] The most commonly discussed barriers inhibiting research were workload, technology limitations and financial considerations. Organisational leadership to prioritise and coordinate research efforts, training to build research capacity, building on existing examples of excellence and initiation of bottom‐up community‐based research projects were identified in our study as opportunities to enhance pharmacist involvement in research and ultimately patient health outcomes.

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. pharma* AND (education OR training)
8. 1 OR 2 OR 3 OR 4 OR 5 OR 6
9. 7 AND 8

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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