Efficacy of serious games in healthcare professions education

List of excluded studies at the full-text assessment stage

Not a study

1.   Borro-Escribano B, Martinez-Alpuente I, Blanco AD, Torrente J, Fernandez-Manjon B, Matesanz R. Application of game-like simulations in the Spanish Transplant National Organization. *Transplantation proceedings.* 2013;45(10):3564-3565.

2.   Cowan B, Sabri H, Kapralos B, Moussa F, Cristancho S, Dubrowski A. A serious game for off-pump coronary artery bypass surgery procedure training. *Studies in health technology and informatics.* 2011;163:147-149.

3.   del Blanco A, Fernandez-Manjon B, Ruiz P, Giner M. Using videogames facilitates the first visit to the operating theatre. *Med Educ.* 2013;47(5):519-520.

4.   Gallagher AG, Traynor O. Simulation in surgery: opportunity or threat? *Ir J Med Sci.* 2008;177(4):283-287.

5.   Heldal I, Backlund P, Johannesson M, Lebram M, Lundberg L. Connecting the Links: Narratives, Simulations and Serious Games in Prehospital Training. *Studies in health technology and informatics.* 2017;235:343-347.

6.   Johnston CL, Whatley D. Pulse!!--A virtual learning space project. *Studies in health technology and informatics.* 2006;119:240-242.

7.   Kerfoot BP, Kissane N. The use of gamification to boost residents' engagement in simulation training. *JAMA surgery.* 2014;149(11):1208-1209.

8.   Magro A, Swarz J, Ousley A. CancerSPACE: An Interactive E-learning Tool Aimed to Improve Cancer Screening Rates. *Journal of Computer-Mediated Communication.* 2010;15(3):482-499.

9.   Semeraro F, Frisoli A, Ristagno G, et al. Relive: a serious game to learn how to save lives. *Resuscitation.* 2014;85(7):e109-110.

10.   Shewaga R, Knox A, Ng G, Kapralos B, Dubrowski A. Z-DOC: a serious game for Z-plasty procedure training. *Studies in health technology and informatics.* 2013;184:404-406.

11.   Smith-Stoner M, Willer A. Innovative use of the Internet and intranets to provide education by adding games. *Computers, informatics, nursing : CIN.* 2005;23(5):237-241.

12.   Truchot-Cardot D. ["Games, to nurse? Is this legitimate?"]. *Krankenpfl Soins Infirm.* 2016;109(2):8-11, 58-61, 82-15.

13.   Young J. Using a Role-Play Simulation Game to Promote Systems Thinking. *J Contin Educ Nurs.* 2018;49(1):10-11.

Not with healthcare professionals or students

1.   Asadipour A, Debattista K, Chalmers A. Visuohaptic augmented feedback for enhancing motor skills acquisition. *Visual Computer.* 2017;33(4):401-411.

2.   Bauer KN, Brusso RC, Orvis KA. Using Adaptive Difficulty to Optimize Videogame-Based Training Performance: The Moderating Role of Personality. *Military Psychology.* 2012;24(2):148-165.

3.   Chan WY, Qin J, Chui YP, Heng PA. A serious game for learning ultrasound-guided needle placement skills. *IEEE Trans Inf Technol Biomed.* 2012;16(6):1032-1042.

4.   Olson DK, Scheller A, Larson S, Lindeke L, Edwardson S. Using gaming simulation to evaluate bioterrorism and emergency readiness education. *Public health reports (Washington, DC : 1974).* 2010;125(3):468-477.

5.   Simic G, Jevremovic A, Kostic Z, Dordevic D. Assessment based on Serious Gaming Interactive Questions (SGIQ). *Journal of Computer Assisted Learning.* 2015;31(6):623-637.

6.   Sotomayor TM. Teaching tactical combat casualty care using the TC3 Sim Game-based simulation: a study to measure training effectiveness. *Studies in Health Technology & Informatics.* 2010;154:176-179.

7.   Sterkenburg PS, Vacaru VS. The effectiveness of a serious game to enhance empathy for care workers for people with disabilities: A parallel randomized controlled trial. *Disabil Health J.* 2018;11(4):576-582.

8.   van Dijk T, Spil T, van der Burg S, Wenzler I, Dalmolen S. Present or Play. *International Journal of Game-Based Learning.* 2015;5(2):55-69.

9.   Yu FY, Han C, Chan TW. Experimental comparisons of face-to-face and anonymous real-time team competition in a networked gaming learning environment. *Cyberpsychol Behav.* 2008;11(4):511-514.

Not a serious game

1.   Amer RS, Denehy GE, Cobb DS, Dawson DV, Cunningham-Ford MA, Bergeron C.
        Development and evaluation of an interactive dental video game to teach dentin bonding.
        J Dent Educ. 2011;75(6):823-831.

2.   Ang ET, Chan JM, Gopal V, Li Shia N. Gamifying anatomy education. *Clin Anat.*
        2018;31(7):997-1005.

3.   Ankay Yilbas A, Canbay O, Akca B, et al. The effect of playing video games on
        fiberoptic intubation skills. *Anaesthesia, critical care & pain medicine.* 2018.

4.   Ankay Yilbas A, Canbay O, Akca B, et al. The effect of playing video games on
        fiberoptic intubation skills. *Anaesthesia, critical care & pain medicine.* 2018.

5.   Blakely G, Skirton H, Cooper S, Allum P, Nelmes P. Use of educational games in the
        health professions: a mixed-methods study of educators' perspectives in the UK. *Nursing
        & health sciences.* 2010;12(1):27-32.

6.   Chalhoub M, Khazzaka A, Sarkis R, Sleiman Z. The role of smartphone game
        applications in improving laparoscopic skills. *Advances in medical education and
        practice.* 2018;9:541-547.

7.   Chang TP, Raymond T, Dewan M, et al. The effect of an International competitive
        leaderboard on self-motivated simulation-based CPR practice among healthcare
        professionals: A randomized control trial. *Resuscitation.* 2019;138:273-281.

8.   Cowan B, Rojas D, Kapralos B, Moussa F, Dubrowski A. Effects of sound on visual
        realism perception and task performance. *Visual Computer.* 2015;31(9):1207-1216.

9.   Creutzfeldt J, Hedman L, Fellander-Tsai L. Effects of pre-training using serious game technology on CPR performance--an exploratory quasi-experimental transfer study. *Scandinavian journal of trauma, resuscitation and emergency medicine.* 2012;20:79.

10.   Diehl LA, Gordan PA, Esteves RZ, Coelho IC. Effectiveness of a serious game for medical education on insulin therapy: a pilot study. *Archives of endocrinology and metabolism.* 2015;59(5):470-473.

11.   El-Beheiry M, McCreery G, Schlachta CM. A serious game skills competition increases voluntary usage and proficiency of a virtual reality laparoscopic simulator during first-year surgical residents' simulation curriculum. *Surgical endoscopy.* 2017;31(4):1643-1650.

12.   Evans DA, Curtis AR. Animosity, antagonism, and avatars: teaching conflict management in second life. *The Journal of nursing education.* 2011;50(11):653-655.

13.   Fonseca LM, Aredes ND, Fernandes AM, et al. Computer and laboratory simulation in the teaching of neonatal nursing: innovation and impact on learning. *Revista latino-americana de enfermagem.* 2016;24:e2808.

14.   Gunn T, Jones L, Bridge P, Rowntree P, Nissen L. The use of virtual reality simulation to improve technical skill in the undergraduate medical imaging student. *Interactive Learning Environments.* 2017;26(5):613-620.

15.   Hashimoto DA, Gomez ED, Beyer-Berjot L, et al. A Randomized Controlled Trial to Assess the Effects of Competition on the Development of Laparoscopic Surgical Skills. *Journal of surgical education.* 2015;72(6):1077-1084.

16.   Hedman L, Schlickum M, Fellander-Tsai L. Surgical novices randomized to train in two video games become more motivated during training in MIST-VR and GI Mentor II than students with no video game training. *Studies in health technology and informatics.* 2013;184:189-194.

17.   Jalink MB, Heineman E, Pierie JP, ten Cate Hoedemaker HO. The effect of a preoperative warm-up with a custom-made Nintendo video game on the performance of laparoscopic surgeons. *Surgical endoscopy.* 2015;29(8):2284-2290.

18.   Lin CC, Huang SC, Lin HH, Huang WJ, Chen WS, Yang SH. Naked-eye box trainer and training box games have similar training effect as conventional video-based box trainer for novices: A randomized controlled trial. *Am J Surg.* 2018;216(5):1022-1027.

19.   Mak WW, Cheng SS, Law RW, Cheng WW, Chan F. Reducing HIV-related stigma among health-care professionals: a game-based experiential approach. *AIDS care.* 2015;27(7):855-859.

20.   McGrath J, Kman N, Danforth D, et al. Virtual alternative to the oral examination for emergency medicine residents. *The western journal of emergency medicine.* 2015;16(2):336-343.

21.   McMullan M, Jones R, Lea S. The effect of an interactive e-drug calculations package on nursing students' drug calculation ability and self-efficacy. *International journal of medical informatics.* 2011;80(6):421-430.

22.   Moglia A, Perrone V, Ferrari V, et al. Influence of videogames and musical instruments on performances at a simulator for robotic surgery. *Minimally invasive therapy & allied*

technologies : MITAT : official journal of the Society for Minimally Invasive Therapy.
2017;26(3):129-134.

23.   Orwoll B, Diane S, Henry D, et al. Gamification and Microlearning for Engagement With
       Quality Improvement (GAMEQI): A Bundled Digital Intervention for the Prevention of
       Central Line-Associated Bloodstream Infection. *American journal of medical quality : the*
       official journal of the American College of Medical Quality. 2018;33(1):21-29.

24.   Rosser JC, Jr., Gentile DA, Hanigan K, Danner OK. The effect of video game "warm-up"
       on performance of laparoscopic surgery tasks. *JSLS : Journal of the Society of*
       Laparoendoscopic Surgeons. 2012;16(1):3-9.

25.   Sapkaroski D, Baird M, McInerney J, Dimmock MR. The implementation of a haptic
       feedback virtual reality simulation clinic with dynamic patient interaction and
       communication for medical imaging students. *Journal of medical radiation sciences.*
       2018;65(3):218-225.

26.   Schlickum MK, Hedman L, Enochsson L, Kjellin A, Fellander-Tsai L. Systematic video
       game training in surgical novices improves performance in virtual reality endoscopic
       surgical simulators: a prospective randomized study. *World journal of surgery.*
       2009;33(11):2360-2367.

Efficacy of serious games in healthcare professions education

No randomized comparator group

1.   Albright G, Adam C, Goldman R, Serri D. A Game-Based Simulation Utilizing Virtual Humans to Train Physicians to Screen and Manage the Care of Patients with Mental Health Disorders. *Games Health J.* 2013;2(5):269-273.

2.   Butt AL, Kardong-Edgren S, Ellertson A. Using Game-Based Virtual Reality with Haptics for Skill Acquisition. *Clin Simul Nurs.* 2018;16:25-32.

3.   Buttussi F, Pellis T, Cabas Vidani A, Pausler D, Carchietti E, Chittaro L. Evaluation of a 3D serious game for advanced life support retraining. *International journal of medical informatics.* 2013;82(9):798-809.

4.   Cowan B, Sabri H, Kapralos B, et al. A serious game for total knee arthroplasty procedure, education and training. *Journal of Cyber Therapy and Rehabilitation.* 2010;3(3):285-298.

5.   Cutumisu M, Brown MRG, Fray C, Schmolzer GM. Growth Mindset Moderates the Effect of the Neonatal Resuscitation Program on Performance in a Computer-Based Game Training Simulation. *Frontiers in pediatrics.* 2018;6:195.

6.   Dankbaar ME, Roozeboom MB, Oprins EA, et al. Preparing Residents Effectively in Emergency Skills Training With a Serious Game. *Simulation in healthcare : journal of the Society for Simulation in Healthcare.* 2017;12(1):9-16.

7.   Hannig A, Kuth N, Ozman M, Jonas S, Spreckelsen C. eMedOffice: a web-based collaborative serious game for teaching optimal design of a medical practice. *BMC medical education.* 2012;12:104.

8.   Kang J, Suh EE. Development and Evaluation of "Chronic Illness Care Smartphone Apps" on Nursing Students' Knowledge, Self-efficacy, and Learning Experience. *Computers, informatics, nursing : CIN.* 2018;36(11):550-559.

9.   Kanthan R, Senger JL. The impact of specially designed digital games-based learning in undergraduate pathology and medical education. *Archives of pathology & laboratory medicine.* 2011;135(1):135-142.

10.   McKenzie K. A comparison of the effectiveness of a game informed online learning activity and face to face teaching in increasing knowledge about managing aggression in health settings. *Advances in health sciences education : theory and practice.* 2013;18(5):917-927.

11.   Middeke A, Anders S, Schuelper M, Raupach T, Schuelper N. Training of clinical reasoning with a Serious Game versus small-group problem-based learning: A prospective study. *PloS one.* 2018;13(9):e0203851.

12.   O'Neill E, Reynolds PA, Hatzipanagos S, Gallagher JE. Graphic (games research applied to public health with innovative collaboration)--designing a serious game pilot for dental public health. *Bull Group Int Rech Sci Stomatol Odontol.* 2013;51(3):e30-31.

13.   Qin J, Chui YP, Pang WM, Choi KS, Heng PA. Learning blood management in orthopedic surgery through gameplay. *IEEE computer graphics and applications.* 2010;30(2):45-57.

14.   Savazzi F, Isernia S, Jonsdottir J, Di Tella S, Pazzi S, Baglio F. Engaged in learning
       neurorehabilitation: Development and validation of a serious game with user-centered
       design. *Computers & Education.* 2018;125:53-61.

15.   Verkuyl M, Romaniuk D, Mastrilli P. Virtual gaming simulation of a mental health
       assessment: A usability study. *Nurse Educ Pract.* 2018;31:83-87.

No engagement or learning outcome

1.   Hawkins GE, Rae B, Nesbitt KV, Brown SD. Gamelike features might not improve data.
       Behav Res Methods. 2013;45(2):301-318.

2.   Kowalewski KF, Hendrie JD, Schmidt MW, et al. Validation of the mobile serious game
       application Touch Surgery for cognitive training and assessment of laparoscopic
       cholecystectomy. *Surgical endoscopy.* 2017;31(10):4058-4066.

3.   Mohan D, Angus DC, Ricketts D, et al. Assessing the validity of using serious game
       technology to analyze physician decision making. *PloS one.* 2014;9(8):e105445.