

Supplementary materials.

Term	Definition
Virtual reality	An immersive experience whereby the user interacts with a video or computer generated simulation from a first person viewpoint, using a monitor or headset device, with or without haptics devices.
Augmented reality	An experience where the user uses a device to view a layer of computer generated information (which may be textual or graphical) overlaid over an image of the physical environment. This does not represent the real world.
Virtual world	A computer generated 3D environment which users can explore via 1st person virtual reality or 3rd person with an avatar.
Avatar	A computer generated figure intended to represent the user within the virtual world.
Haptics device	A device which provides tactile feedback, such as resistance, to the user.

Supplementary material Table 1. Definition of terms.

Final articles for inclusion in review

Butt, A., Kardong-Edgren, S., Ellertson, A. (2018) Using Game-Based Virtual Reality with Haptics for Skill Acquisition. *Clinical Simulation in Nursing*. Vol. 16, pp. 25-32

Davis-Reyes, S., Stillsmoking, K., Chadwick-Hopkins, D. (2008) Implementation and Evaluation of a Virtual Simulator System: Teaching Intravenous Skills. *Clinical Simulation in Nursing*. Vol. 4, pp. e43-e49

Engum, S., Jeffries, P., Fisher, L. (2003) Intravenous catheter training system: Computer-based education versus traditional learning methods. *The American Journal of Surgery*. Vol. 186, pp. 67–74

Gunay-Ismailoglu, E., Zaybak, A. (2018) Comparison of the effectiveness of a virtual simulator with a plastic arm model in teaching intravenous catheter insertion skills. *CIN: Computers, Informatics, Nursing*. Vol. 36, no. 2, pp. 98-105

Jamison, R., Hovancsek, M., Clochesy, J. (2006) A Pilot Study Assessing Simulation Using Two Simulation Methods for Teaching Intravenous Cannulation. *Clinical Simulation in Nursing*. Vol. 2, pp. e9-e12

Jung, E., Park, D., Lee, Y., Jo, H., Lim, Y., Park, R. (2012) Evaluation of practical exercises using an intravenous simulator incorporating virtual reality and haptics device technologies. *Nurse Education Today*. Vol. 32, pp. 458–463

Smith, P., Hamilton, B. (2015) The Effects of Virtual Reality Simulation as a Teaching Strategy for Skills Preparation in Nursing Students. *Clinical Simulation in Nursing*. Vol. 11, pp. 52-58

Vidal, V., Ohaeri, B, John, P, Helen, D. (2013) Virtual reality and the traditional method for phlebotomy training among college of nursing students in Kuwait. *Journal of Infusion Nursing*. Vol. 36, no. 5, pp. 349-355

William, A., Vidal, V., John, P. (2016) Traditional Instruction Versus Virtual Reality Simulation: A Comparative Study of Phlebotomy Training among Nursing Students in Kuwait. *Journal of Education and Practice*. Vol. 7, no. 9, pp. 18-25

Supplementary Table 2. Final articles for inclusion in review.

Citation	Was the method used to generate random allocations adequate?	Was the allocation concealed?	Were the groups similar at the outset of the study?	Were the assessors blind to group allocation?	Were any unexpected imbalances in drop-outs between groups adequately explained or addressed?	Does it appear that the authors report all outcomes measured?
Butt, Kardong-Edgren & Ellertson (2018)	P	NA	✓	✓	✓	✓
Davis-Reyes, Stillsmoking & Chadwick-Hopkins (2008)	✓	NA	X	NS	NS	PS
Engum, Jeffries & Fisher (2003)	✓	NA	PS	NS	✓	PS
Gunay-Ismailoglu & Zaybak (2018)	✓	NA	✓	✓	✓	✓
Jamison, Hovancsek & Clochesy (2006)	✓	NA	✓	P	✓	PS
Jung et al (2012)	✓	NA	✓	✓	✓	✓
Smith & Hamilton (2015)	✓	NA	✓	NS	✓	✓
Vidal, Ohaeri, John & Helen (2013)	NS	NA	X	NS	✓	PS
William, Vidal & John (2016)	✓	NA	NS	NS	✓	PS
✓ = Adequately addressed X = Not adequately addressed P = Partially addressed NA = Not applicable NS = Not stated PS = Partially stated						

Supplementary Table 3. Results of critical appraisal.

Study	Cognitive gain Mean difference between pre and posttest score			
	VR group n (SD)	Simulation group n (SD)	3rd group (if applicable) n (SD)	Significance
Butt et al (2018)	na	na	na	na
Davis-Reyes et al (2008)	14.7 (11.0)	11.6 (11.26)	na	p= 0.461 t=0.74*
Engum et al (2003)	NS	NS	na	na
Gunay-Ismailoglu & Zaybak (2018)	32.61 (13.53)	35.03 (14.97)	na	p=0.537 z= -0.617**
Jamison et al (2006)	NS 1.5 calc	NS 0.22 calc	na	na
Jung et al (2012)	na	na	na	na
Smith & Hamilton (2015)	na	na	na	na
Vidal et al (2013)	na	na	na	na
William et al (2016)	na	na	na	na
NS = not stated, na = not applicable *t-test **Mann-Whitney U test				

Supplementary Table 4. Cognitive gain scores.

Study	Skill successfully demonstrated (mannequin)				Skill successfully demonstrated (human)			
	VR group n (%)	Simulation group n (%)	3rd group (if applicable) n (%)	Significance	VR group n (%)	Simulation group n (%)	3rd group (if applicable) n (%)	Significance
Butt et al (2018)	NS (60)	NS (60)	na	NS	na	na	na	na
Davis-Reyes et al (2008)	na	na	na	na	NS (64)	NS (78)	na	NS
Engum et al (2003)	na	na	na	na	NS	NS	na	NS
Gunay-Ismailoglu & Zaybak (2018)	na	na	na	na	na	na	na	na
Jamison et al (2006)	na	na	na	na	na	na	na	na
Jung et al (2012)	na	na	na	na	23 (60.5)	18 (47.4)	14 (36.8)	p=0.117
Smith & Hamilton (2015)	10 (100)	9 (90)	na	NS	na	na	na	na
Vidal et al (2013)	na	na	na	na	46 (100)	27 (100)	na	NS
William et al (2016)	na	na	na	na	29 (100)	22 (100)	na	NS

NS = not stated na = not applicable

Supplementary table 5. Number of participants who successfully demonstrated the skill after intervention.

Study	Mean time to complete skill in seconds † (human)			
	VR group n (SD)	Simulation group n (SD)	3rd group (if applicable) n (SD)	Significance
Butt et al (2018)	na	na	na	na
Davis-Reyes et al (2008)	na	na	na	na
Engum et al (2003)	na	na	na	na
Gunay-Ismailoglu & Zaybak (2018)	na	na	na	na
Jamison et al (2006)	na	na	na	na
Jung et al (2012)	182.79 (48.63)	164.11 (65.09)	141.08 (53.41)	p=0.007
Smith & Hamilton (2015)	na	na	na	na
Vidal et al (2013)	NS	NS	NS	NS
William et al (2016)	807.0 (773.64)	1240.2 (1243.68)	na	p=1.01
NS = not stated na = not applicable † William et al study reported in minutes, results converted to seconds for this review.				

Supplementary table 6. Mean time taken for participants to complete the skill after intervention.