Supplemental Digital List 1

Full Search Strategy for a Systematic Review of Computerized Virtual Patients: Search Date August 22, 2008; Update February 16, 2009

KEY
Information is presented as search terms, then number of articles identified in parentheses
Exp = explode
/ identifies a controlled vocabulary term
Adj = adjacent, i.e., adj3 = within 3 words
Mp = multiple locations
$ = wild card

Ovid MEDLINE, Ovid CINAHL (Aug. 08), Ovid PsychINFO
1. exp education, professional/ (192,645)
2. medical education.mp *or* exp education, medical/ (107,021)
3. virtual patient$.mp (187)
4. 1 *or* 2 (196,288)
5. 3 *and* 4 (62)
6. case-based learning.mp (102)
7. problem based learning.mp *or* Problem-Based Learning/ (3,710)
8. computer simulat$.mp (87,177)
9. 6 *or* 7 (3,771)
10. 8 *and* 9 (94)
11. clinical simulat$.mp (186)
12. 4 *and* 8 *and* 11 (21)
13. 10 *or* 12 *or* 5 (171)

EBSCO CINAHL (Feb. 09 update)
CINAHL has moved to the EBSCO platform, so the update was performed keeping as close as possible to the original strategy.

Ovid EMBASE
1. exp education, professional/ (3,120)
2. medical education.mp *or* exp education, medical/ (90,730)
3. virtual patient$.mp (125)
4. 1 *or* 2 (93,299)
5. 3 *and* 4 (49)
6. case-based learning.mp (75)
7. problem based learning.mp *or* Problem-Based Learning/ (1,276)
8. computer simulat$.mp (19,328)
9. 6 *or* 7 (1,344)
10. 8 *and* 9 (15)
11. clinical simulat$.mp (75)
12. 4 *and* 8 *and* 11 (6)
13. 10 *or* 12 *or* 5 (69)

Ovid ERIC
1. medical education {Including Limited Related Terms} (736)
2. virtual patient {Including Limited Related Terms} (25)
3. case-based learning {Including Limited Related Terms} (6,273)
4. problem-based learning {Including Limited Related Terms} (514)
5. computer simulation {Including Limited Related Terms} (521)
6. clinical simulation {Including Limited Related Terms} (263)
7. nursing education {Including Limited Related Terms} (631)
8. nurse education {Including Limited Related Terms} (607)
9. internship {Including Limited Related Terms} (1,229)
10. residency {Including Limited Related Terms} (733)
11. 1 *or* 7 *or* 8 *or* 9 (3,073)
12. 3 *or* 4 *or* 5 *or* 6 (7,509)
13. 11 *and* 12 (32)
14. 2 *or* 13 (57)
15. from 14 keep 1-57 (57)

Scopus
(TITLE-ABS-KEY((simulat* OR virtual) AND (clinical OR patient*) AND ("computer-based" OR "problem-based" OR "case-based")) AND TITLE-ABS-KEY((educat* OR instruct* OR train* OR teach*) AND (clinical* OR medical OR nursing OR dentist* OR "internship and residency") AND (random* OR compar* OR random*))) AND TITLE(simulat* OR virtual) **(**89)

University of Toronto Research and Development Resource Base
Keywords: (“virtual”) OR (“simulator”) OR (“simulation”)
Keywords: (“patient”) OR (“clinical”)
Keywords: (“comparative”) (0 unique hits)

Supplemental Digital List 2

Duplicate Reports Identified in a 2009 Systematic Review of Research on Virtual Patients*

Friedman 1989[147] – see Friedman 1991[36]
Lyon 1991[148] – see Lyon 1991[39]
Bearman 2001[149] – see Bearman 2001[76]
Cohen 2007[150] – see Deladisma 2007[126]
Dev 2007[151] – see Youngblood 2008[145]

* When we encountered duplicate reporting of the same research study, we selected one report (the most detailed; listed on the right) for full review, and did not review the other report (on the left) in full. See Supplemental Tables 1 and 2 for details about the reports reviewed in full.

Supplemental Digital Table 1

All Articles Reporting Original Research or Descriptions of Virtual Patients Identified in a 2009 Systematic Review of Research on Computerized Virtual Patients*

Author, year	Targeted learners	Clinical topic	Information requests†	Case progression‡	Collaboration§	Outcomes¶	Included in full review
Bitzer, 1966[1]	Nursing students	Myocardial infarction	M	F	A	K	Yes
de Dombal, 1969[2]	Medical students	Surgery	F	V	A		No
de Dombal, 1969[3]	Medical students	Surgery	F	V	A		No
Harless, 1971[4]	Medical students	Various topics	F	F	A		No
Cassidy, 1972[5]	Dental students	Toothache	M	F	A	C	Yes
Friedman, 1973[6]	Medical students, physicians	Various topics	F	F	A	R,C	No
Harless, 1973[7]	Medical students	Generic	F	F	ND		No
Hoffer, 1973[8]	Medical students, residents	Endocrinology	F	B	A		No
Mullaney, 1976[9]	Dental students	Endodontics	F	L	A	R,C	Yes
Murray, 1977[10]	Medical students	General medicine topics	M	ND	A	K,C	Yes
Webster, 1979[11]	Physicians in practice	Internal medicine	ND	ND	A	C	No
Tira, 1980[12]	Dental students	Dental evaluation	M	F	A		No
Lewis, 1981[13]	Medical students	Generic	M	F	A		No
Windom, 1981[14]	Physical therapy students	Communication	ND	ND	A		No
Raj, 1982[15]	Medical students	Not specified	M	B	A		No
Schleutermann, 1983[16]	Nurse practitioner students	Ambulatory medicine	M	B	A	R,S	Yes
Abdulla, 1984[17]	Medical students	Not specified	ND	B	A		No
Dale, 1986[18]	Dental students	Clinical endodontics	M	L	A	R,C	Yes
Diserens, 1986[19]	Medical students, residents	Internal medicine topics	M	F	A	C	No
Garrett, 1986[20]	Residents	Lung cancer	M	ND	A	C	Yes
Harless, 1986[21]	Medical students	Alcoholic liver disease	F	B	G		No
Harless, 1986[22]	Medical students	Alcoholic liver disease	F	B	G		No

Author, year	Targeted learners	Clinical topic	Information requests†	Case progression‡	Collaboration§	Outcomes¶	Included in full review
Krahn, 1986[23]	Medical students	Acid-base disturbances	ND	L	A	K	Yes
Norcini, 1986[24]	Physicians in practice	Internal medicine	F	ND	A	R,C	No
Pickell, 1986[25]	Medical students	Not specified	F	F	AG		No
Eisenberg, 1987[26]	Medical students, residents	Internal medicine	M	L	A	C	No
Sandoval, 1987[27]	Dental students	Endodontics	M	L	A	R,C	Yes
Verbeek, 1987[28]	Medical students	Not specified	M	F	A		No
Finkelstein, 1988[29]	Dental students	Dental evaluation	M	F	A		No
Gerritsma, 1988[30]	Physicians in practice	Various	M	F	A	R,C	No
Beck, 1989[31]	Medical students	Cardiology	M	F	A		No
Harless, 1990[32]	Medical students	Gastrointestinal bleed, obesity	F	B	G	K	Yes
Lyon, 1990[33]	Medical students	Chest pain, anemia	ND	ND	A	K	Yes
Engberg, 1991[34]	Residents	Gynecology	F	F	A	S	No
Finkelstein, 1991[35]	Dental students	Dental evaluation	M	F	A		No
Friedman, 1991[36]	Medical students	Various medical topics	F	B	A	R,K	Yes
Hayes, 1991[37]	Physical therapy students	Physical therapy referrals	M	B	A	R,C	No
Lowdermilk, 1991[38]	Nursing students	Various clinical nursing topics	ND	ND	A	C	Yes
Lyon, 1991[39]	Medical students	Chest pain, anemia	ND	ND	A	K	Yes
Henry, 1992[40]	Nurses	Tachyarrhythmia	ND	B	A	K,S	No
Pincetl, 1992[41]	Medical students, allied health students	Geriatric medicine	F	B	AG		No
Ajmani, 1993[42]	Medical students	Generic	M	B	ND		No
Clark, 1993[43]	Dental students	Temporomandibular disorders, oral pain	M	F	A	C	No
Clauser, 1993[44]	Medical students	Pediatrics	F	B	A	C	No
Henry, 1993[45]	Nurses in practice	Tachyarrhythmia	ND	B	A	K,S	No
Cobbs, 1994[46]	Medical students	Geriatric medicine	M	B	A		No
Felciano, 1994[47]	Medical students	Neonatal care	M	F	A		No
MacDonald, 1994[48]	Medical students	Pediatric infectious disease	M	B	A		No

Author, year	Targeted learners	Clinical topic	Information requests†	Case progression‡	Collaboration§	Outcomes¶	Included in full review
Myers, 1994[49]	Medical students	Generic	ND	ND	ND		No
Berger, 1995[50]	Medical students	Generic	ND	B	A		No
Johnson, 1995[51]	Medical students	Pulmonary pathophysiology	M	F	A		No
Rouhani, 1995[52]	Medical students, residents	Pediatric rheumatology	M	F	A		No
Dorsey, 1996[53]	Medical students	Sexual abuse	ND	ND	A	R,K	No
Hayes, 1996[54]	Medical students, resident	Back pain	F	F	A		No
Weverling, 1996[55]	Medical students	Neurology	M	F	A	K	Yes
Bryce, 1997[56]	Medical students	Various topics	ND	ND	G		No
Farnsworth, 1997[57]	Veterinary students	Neuroanatomy	ND	ND	G	C	No
Johnson, 1997[58]	Dental hygienists	Geriatric dental hygiene	M	B	A	C	Yes
Kinney, 1997[59]	Physical therapy students	Carpal tunnel syndrome	ND	ND	A	K	Yes
Vahl, 1997[60]	Clinical researchers	Cardiovascular surgery (research calibration)	M	L	A		No
Bryce, 1998[61]	Medical students	Not specified	M	B	G	,Q	Yes
Christensen, 1998[62]	Medical students, resident	Cardiac resuscitation	M	B	ND		No
Henderson, 1998[63]	Physicians, nurse practitioners, physician assistants in practice	HIV/AIDS	M	V	A		No
Loke, 1998[64]	Medical students	Peptic ulcer	M	V	A		No
Pinto, 1998[65]	Medical students	Pathophysiology	ND	ND	G		No
Vick, 1998[66]	Dental students	Periodontal dentistry	M	L	AG		No
Weis, 1998[67]	Nursing students	Abdominal pain	F	L	A		No
Downs, 1999[68]	Medical students	Infectious disease	M	F	A		No
Rendas, 1999[69]	Medical students	Pathophysiology	M	L	G		No
Schwid, 1999[70]	Residents, physicians in practice	ACLS	M	B	A	S	Yes
Bremner, 2000[71]	Nursing students	Various topics	M	L	A		No
Clauser, 2000[72]	Medical students	Various topics	F	B	A	C	No
Fleetwood, 2000[73]	Medical students	Medical ethics	FM	F	A	K,S	Yes

Author, year	Targeted learners	Clinical topic	Information requests†	Case progression‡	Collaboration§	Outcomes¶	Included in full review
Hubal, 2000[74]	Medical students	Generic	F	F	ND		No
Reece Jones, 2000[75]	Nurses in practice	Nursing care	ND	F	A		No
Bearman, 2001[76]	Medical students	Communication skills	M	F	A	S	Yes
Garrett, 2001[77]	Nursing students	Not specified	ND	F	ND		No
Schwid, 2001[78]	Residents	Anesthesia emergencies	M	B	A	S	Yes
Abbey, 2002[79]	Dental students	Dental evaluation	ND	F	A		No
Buysse, 2002[80]	Medical students	Ambulatory medicine	ND	ND	A	R	Yes
Grabowski, 2002[81]	Medical students	Emergency medicine	M	F	A	R	No
Maulitz, 2002[82]	Medical students	Generic	ND	ND	ND		No
Oliffe, 2002[83]	Nursing students	Pediatric nursing	ND	V	A	R	No
Abbey, 2003[84]	Dental students	Dental evaluation	F	ND	A		No
Bearman, 2003[85]	Medical students	Communication, chest pain	M	V	A	,Q	Yes
Bergin, 2003[86]	Medical students	Fever of unknown origin	F	F	G	R,Q	Yes
Bergin, 2003[87]	Medical, dental, nursing students	Various topics	F	F	A	R	No
Chaikoolvatana, 2003[88]	Pharmacy students	Pharmacy care plans	F	F	A	S	Yes
Halvorsrud, 2003[89]	Physicians in practice, medical students	Acute trauma	M	B	G	R,S	No
Kumta, 2003[90]	Medical students	Orthopedics	ND	L	AG	S	Yes
Littlefield, 2003[91]	Dental students	Endodontics	M	F	A	R,K,C	No
Nielson, 2003[92]	Medical students	Not specified	M	ND	ND		No
Tochtermann, 2003[93]	Clinical researchers	Cardiovascular surgery (research calibration)	M	L	A		No
D'Alessandro, 2004[94]	All health professionals	Pediatrics	ND	L	A	R	No
Hayes-Roth, 2004[95]	Medical students, Nursing students	Motivational interviewing	F	F	A	R,S	Yes
Jerant, 2004[96]	Medical students	Internal medicine	M	F	A	K,C	No
Rascher, 2004[97]	Medical students	Pediatrics	ND	L	AG	R	No
Ruderich, 2004[98]	Medical students	Not specified	F	F	G	R	No
Schittek Janda, 2004[99]	Dental students	Interviewing skills	F	B	A	S	Yes

Author, year	Targeted learners	Clinical topic	Information requests†	Case progression‡	Collaboration§	Outcomes¶	Included in full review
Shyu, 2004[100]	Medical students, residents	Generic	ND	F	ND		No
Watkinson, 2004[101]	Nursing students	Generic	ND	L	ND		No
Deterding, 2005[102]	Medical students	Pediatrics	F	ND	A		No
Dickerson, 2005[103]	Medical students	Abdominal pain	F	F	A		No
Fall, 2005[104]	Medical students	Pediatrics	M	L	A	R	No
Johnsen, 2005[105]	Medical students	Abdominal pain	F	F	A	R,C	No
Johnsen, 2005[106]	Medical students	Abdominal pain	F	F	A	R,C	No
Jung, 2005[107]	Medical students	Social interactions	M	B	A		No
Mallott, 2005[108]	Medical students	Surgery, gynecology, medicine	M	L	A	,Q	Yes
Ong, 2005[109]	Physicians	Trauma	M	B	A		No
Walsh, 2005[110]	Physicians in practice	Not specified	ND	ND	ND		No
Dickerson, 2006[111]	Medical students	Abdominal pain	F	F	A	R,S	Yes
Ferguson, 2006[112]	Residents	Developmental disabilities	M	L	A	K,S	Yes
Kabanza, 2006[113]	Medical students	Various topics	FM	F	A		No
Owen, 2006[114]	Residents	Medical emergencies	M	ND	A	K,S	No
Raij, 2006[115]	Medical students	Abdominal pain	F	F	A	R,C,S	Yes
Roy, 2006[116]	Physicians	Bioterrorism	F	F	A		No
Stevens, 2006[117]	Medical students	Abdominal pain	F	F	A	R	No
Thompson, 2006[118]	Medical students	Cardiology and bioterrorism	ND	ND	A	K,C	Yes
Triola, 2006[119]	Nurses, physicians, psychologists, other	Distress disorders	M	F	A	R,C	Yes
Turner, 2006[120]	Medical students	Abdominal pain, headache	M	B	A	R,C,S	Yes
Villaume, 2006[121]	Pharmacy students	Motivational interviewing	M	B	ND		No
Wahlgren, 2006[122]	Medical students	Dermatology, venereology	ND	F	A	K	Yes
Waldmann, 2006[123]	Medical students	Various topics	ND	ND	A	R	No
Wilson, 2006[124]	Medical students	Rheumatology	ND	F	A	R,C	No

Author, year	Targeted learners	Clinical topic	Information requests†	Case progression‡	Collaboration§	Outcomes¶	Included in full review
Zary, 2006[125]	Medical, dental, pharmacy students	Various topics	M	F	A	R	No
Deladisma, 2007[126]	Medical students	Abdominal pain	F	F	A	S	Yes
Haag, 2007[127]	Medical students	Not specified	ND	F	A	R	No
Jarrell, 2007[128]	Medical students	Gastroesophageal reflux	M	B	ND		No
Kleinert, 2007[129]	Physician assistant students	Developmental disabilities	M	L	A	K,S	Yes
Kleinert, 2007[130]	Dental students	Developmental disabilities	M	L	A	K,S	Yes
McKenzie, 2007[131]	Clinical psychologists	Learning disabilities	ND	B	ND		No
Raij, 2007[132]	Medical students	Abdominal pain	F	F	A	C,S	Yes
Sanders, 2007[133]	Nursing students	Developmental disabilities	M	L	A	K,S	Yes
Sijstermans, 2007[134]	Medical students	Inter-physician communication	M	F	G	C	Yes
Smith, 2007[135]	Medical students	Various topics	ND	ND	G	R	No
Sumner, 2007[136]	Residents	Coronary artery disease	F	B	ND		No
Vash, 2007[137]	Medical students	Abdominal pain	FM	F	G	K,C	Yes
Boyd, 2008[138]	Physician assistant students, nursing students, residents	Developmental disabilities	M	L	A	K,S	Yes
Courteille, 2008[139]	Medical students	Various topics	F	F	A	R,C	No
Orton, 2008[140]	Medical students	Geriatric medicine	M	V	AG	R	No
Parsons, 2008[141]	Residents	Psychiatry	F	F	A		No
Sanders, 2008[142]	Dental students	Developmental disabilities in dentistry	M	L	A	K,S	Yes
Sanders, 2008[143]	Nurse practitioner students	Developmental disabilities	M	L	A	K,S	Yes
Waldmann, 2008[144]	Medical students	General medicine	M	F	A	R,C	No
Youngblood, 2008[145]	Medical students, residents	Trauma management	M	B	G	R,S	Yes
Dillon, 2009[146]	Residents	Various topics	F	B	A	C	No

* See Cook, David A, et al. Computerized virtual patients in health professions education: a systematic review and meta-analysis. Acad Med. 2010, published ahead of print and also in the October 2010 issue, for additional information, including term definitions. Note that citation reference numbers in this table will not match the reference numbers in the article full text.
† Information requests: F = free text (natural language), M = menu, ND = not defined.
‡ Case progression: B = branching, F = free navigation, L = linear, ND = not defined, V = varies.
§ Collaboration: A = learners worked alone, G = learners worked in groups, AG = worked alone and in groups.
¶ Outcomes: B = behaviors, C = clinical reasoning, K = knowledge, P = patient effects, Q = qualitative, R = satisfaction (reaction), S = skills.

Supplemental Digital Table 2

Detailed Description of 43 Comparative Studies that were Reviewed in Full and Included in a 2009 Systematic Review of Research on Computerized Virtual Patients*

					Virtual patient‡				Comparison intervention‡			
Author, year	Participants, no.†	Design	Clinical topic	Integrated	Int.	FB	LS	Comp.§	Int.	FB	LS	Outcomes¶
Bitzer, 1966[1]	NS; N=14	Pretest-posttest, 2 groups	Myocardial infarction	No	High	Med.	Few	T	Med.	Low	Many	K
Cassidy, 1972[5]	DS	Pretest-posttest, 1 group	Toothache	No	High	High	Mod.					C
Mullaney, 1976[9]	DS; N=147	Posttest-only, 3 groups	Endodontics	No	Low	Low	Few	1.VP/CAI 2.ST	1.Med. 2.Med.	1.Med. 2.Med.	1.Few 2.Few	R,C
Murray, 1977[10]	MS; N=22	Pretest-posttest, 2 groups	General medicine topics	No	Med.	Low	Few	NI				K,C
Schleutermann, 1983[16]	NPS; N=12	Posttest-only, 2 groups	Ambulatory medicine	No	High	Low	Few	P	High	Low	Few	R,S
Dale, 1986[18]	DS; N=24	Posttest-only, 2 groups	Clinical endodontics	No	Med.	Med.	Few	VP/CAI	Med.	Med.	Few	R,C
Garrett, 1986[20]	R; N=14	Pretest-posttest, 1 group	Lung cancer	No	Med.	Med.	Few					C
Krahn, 1986[23]	MS; N=79	Pretest-posttest, 2 groups	Acid-base disturbances	No	Med.	Low	Mod.	VP/CAI	Med.	Low	Few	K
Sandoval, 1987[27]	DS; N=105	Pretest-posttest, 8 groups**	Endodontics	Yes	Med.	Med.	Few	1.ST 2.P 3.VP/CAI	1.Low 2.Med. 3.Med.	1.Low 2.Med. 3.Med.	1.Few 2.Few 3.Few	R,C
Harless, 1990[32]	MS; N=80	Pretest-posttest, 1 group	GI bleed, obesity	Yes	Med.	Med.	Few					K

					Virtual patient[‡]				Comparison intervention[‡]			
Author, year	Participants, no.[†]	Design	Clinical topic	Integrated	Int.	FB	LS	Comp.[§]	Int.	FB	LS	Outcomes[¶]
Lyon, 1990[33]	MS; N=176	Posttest-only, 2 groups	Chest pain, anemia	Yes		Med.	Many	VP/CAI		Med.	Many	K
Friedman, 1991[36]	MS; N=80	Posttest-only, 3 groups	Various medical topics	Yes	Med.	Low	Few	1.VP/CAI 2.VP/CAI	1.High 2.High	1.High 2.High	1.Mod. 2.Mod.	R,K
Lowdermilk, 1991[38]	NS; N=64	Pretest-posttest, 2 groups	Various clinical nursing topics	No	Med.		Few	CT			Few	C
Lyon, 1991[39]	MS; N=169	Pretest-posttest, 2 groups	Chest pain, anemia	No		Med.	Many	P		Med.	Few	K
Weverling, 1996[55]	MS; N=103	Posttest-only, 2 groups	Neurology	No	Med	Med.	Few	NI				K
Johnson, 1997[58]	DH; N=58	Pretest-posttest, 3 groups	Geriatric dental hygiene	No	High	High	Mod.	1.T 2.NI			1.Few	C
Kinney, 1997[59]	PTS; N=10	Pretest-posttest, 2 groups	Carpal tunnel syndrome	No	Med.		Few	T	Med.	Med.	Mod.	K
Bryce, 1998[61]	MS; N=110	Posttest-only, 2 groups	Not specified	No	High	High	Many	NI				K[††]
Schwid, 1999[70]	R, PP; N=45	Posttest-only, 2 groups	ACLS	No	High	High	Mod.	P	Low	Low	Few	S
Fleetwood, 2000[73]	MS; N=173	Posttest-only, 2 groups	Medical ethics	Yes	High	Med.	Mod.	T	High	Med.	Mod.	K,S
Bearman, 2001[76]	MS; N=255	Posttest-only, 3 groups	Communication skills	Yes	High	Med.	Mod.	1.VP/CAI 2.NI	1.High	1.Med.	1.Mod.	S
Schwid, 2001[78]	R; N=31	Posttest-only, 2 groups	Anesthesia emergencies	No	High	High	Mod.	P	Low	Low	Few	S
Buysse, 2002[80]	MS; N=82	Posttest-only, 2 groups	Ambulatory medicine	Yes			Few	VP/CAI			Few	R
Chaikoolvatana, 2003[88]	PS; N=79	Posttest-only, 2 groups	Pharmacy care plans	Yes	High	Low	Mod.	SP	High	Low	Few	S
Kumta, 2003[90]	MS; N=163	Posttest-only, 2 groups	Orthopedics	No	High	Med.	Many	CT,T	High		Mod.	S

					Virtual patient[‡]				Comparison intervention[‡]			
Author, year	Participants, no.[†]	Design	Clinical topic	Integrated	Int.	FB	LS	Comp.[§]	Int.	FB	LS	Outcomes[¶]
Hayes-Roth, 2004[95]	MS, NS; N=31	Posttest-only, 2 groups	Motivational interviewing	No	High	High	Few	VP/CAI	Low	Low	Few	R,S
Schittek Janda, 2004[99]	DS; N=50	Posttest-only, 2 groups	Interviewing skills	Yes	High	Med.	Mod.	NI				S
Dickerson, 2006[111]	MS; N=17	Posttest-only, 2 groups	Abdominal pain	No	High	Low	Few	VP/CAI	High	Low	Few	R,S
Ferguson, 2006[112]	R; N=30	Pretest-posttest, 1 group	Developmental disabilities	Yes	Med.	Med.	Few					K,S
Raij, 2006[115]	MS; N=24	Posttest-only, 2 groups	Abdominal pain	No	High	Low	Few	SP	High	Low	Few	R,C,S
Thompson, 2006[118]	MS; N=96	Posttest-only, 2 groups	Cardiology and bioterrorism	No	High	High	Many	VP/CAI	Med.	Med.	Mod.	K,C
Triola, 2006[119]	NP, PP, Psychologist, Other; N=55	Pretest-posttest, 2 groups	Distress disorders	No	High	High	Mod.	SP	High	High	Mod.	R,C
Turner, 2006[120]	MS; N=30	Posttest-only, 2 groups	Abdominal pain, headache	No	High	High	Many	SP	High	High	Few	R,C,S
Wahlgren, 2006[122]	MS; N=116	Posttest-only, 2 groups	Dermatology, venereology	No	Med.	Med.	Many	NI				K
Deladisma, 2007[126]	MS; N=84	Posttest-only, 2 groups	Abdominal pain	No	High	Low	Mod.	SP	High	Low	Mod.	S
Kleinert, 2007[129]	PAS; N=42	Pretest-posttest, 1 group	Developmental disabilities	Yes	Med.	High	Few					K,S
Kleinert, 2007[130]	DS; N=51	Pretest-posttest, 1 group	Developmental disabilities	Yes	Med.	High	Few					K,S
Raij, 2007[132]	MS; N=58	Posttest-only, 2 groups	Abdominal pain	Yes	High	Low	Few	SP	High	Low	Few	C,S
Sanders, 2007[133]	NS; N=98	Pretest-posttest, 1 group	Developmental disabilities	Yes	Med.	High	Few					K,S

Author, year	Participants, no. [†]	Design	Clinical topic	Integrated	Virtual patient [‡]			Comp. [§]	Comparison intervention [‡]			Outcomes [¶]
					Int.	FB	LS		Int.	FB	LS	
Sijstermans, 2007[134]	MS; N=134	Pretest-posttest, 1 group	Inter-physician communication	No	High	Low	Many					C
Vash, 2007[137]	MS; N=48	Posttest-only, 2 groups	Abdominal pain	No	High	Low	Mod.	CT	Med.	Med.	Few	K,C
Boyd, 2008[138]	PAS, NS, R; N=101	Pretest-posttest, 1 group	Developmental disabilities	No	Med.	High	Few					K,S
Sanders, 2008[142]	DS; N=44	Pretest-posttest, 1 group	Developmental disabilities	Yes	Med.	High	Few					K,S
Sanders, 2008[143]	NPS; N=35	Pretest-posttest, 1 group	Developmental disabilities	Yes	Med.	High	Few					K,S
Youngblood, 2008[145]	MS, R; N=30	Pretest-posttest, 2 groups	Trauma management	No	High	Med.	Few	HPS		High	Few	R,S

[*] Note that citation reference numbers in this table will not match the reference numbers in article full text.
[†] NS = nursing students; DS = dental students; MS = medical students; NPS = nurse practitioner students; R = residents (physicians in postgraduate training); DH = dental hygienists; PTS = physical therapy students; PP = physicians in practice; NP = nurses in practice; PAS = physician assistant students.
[‡] Int. = cognitive interactivity (low, medium, high), FB = feedback (low, medium, high), LS = learning strategies (few, moderate, many). Blank cells indicate insufficient information to code.
[§] Comparison intervention: CT = clinical teaching, HPS = human patient simulator (manikin), P = paper (handout, textbook, or latent image cases), NI = no intervention control group, SP = standardized patient, ST = slide-tape, T = traditional (typically lecture), VP/CAI = virtual patient / computer-assisted instruction. Blank cells indicate no comparison group (i.e., 1-group pretest-posttest study).
[¶] Outcomes reported in text: R = reaction (satisfaction), K = knowledge, C = clinical reasoning, S = skills.
** Sandoval[27] compared slide-tape instruction, latent image paper cases, 2 virtual patients, and 4 combinations of these interventions (8 groups). We abstracted information on the 4 main interventions.
[††] Insufficient data reported to determine effect size.

Supplemental Digital Table 3

Subgroup Analyses Comparing Outcomes for Different Study Design and Virtual Patient Design Features for Studies Included in a 2009 Systematic Review of Research on Computerized Virtual Patients

Feature	Level or feature	No. studies	Pooled effect size*	Lower CI	Upper CI	I^2	*P* for interaction†
Comparisons with no intervention							
All studies‡		17	0.78	0.58	0.97	79	
Study design	2-group	6	0.49	0.25	0.73	40	0.015
	1-group pretest-posttest	11	0.92	0.67	1.16	83	
Blinded outcome	Yes	11	0.78	0.49	1.07	82	0.87
	No	6	0.81	0.58	1.04	63	
Quality score	≥4	4	0.51	0.14	0.87	64	0.11
	≤3	13	0.86	0.64	1.08	80	
Participants	Medical students	6	0.53	0.18	0.88	85	
	Dental students	4	1.21	0.70	1.71	70	
	Other students	4	0.72	0.52	0.92	45	
	Practitioners	3	0.92	0.24	1.60	79	
Interactivity	High	5	0.68	0.27	1.10	82	0.58
	Low	12	0.82	0.59	1.06	79	
Feedback	High	8	0.88	0.62	1.13	75	0.36
	Low	9	0.69	0.38	1.00	82	
Instructional strategies	Moderate/high	6	0.63	0.26	0.99	80	0.28
	Few	11	0.87	0.62	1.11	80	
Time spent learning§	≥1 hour	3	0.66	0.32	0.99	33	0.78
	<1 hour	2	0.53	-0.33	1.40	81	
Comparisons with non-virtual-patient interventions							
All studies		21	0.08	-0.13	0.30	78	
Study design	Randomized	13	0.22	-0.08	0.51	79	0.10
	Nonrandomized	8	-0.14	-0.45	0.17	74	
Blinded outcome	Yes	13	0.16	-0.13	0.45	73	0.43
	No	8	-0.02	-0.36	0.32	85	
Quality score	≥4	13	0.18	-0.09	0.46	69	0.29
	≤3	8	-0.07	-0.43	0.30	86	
Participants	Medical students	9	-0.02	-0.36	0.31	84	

	Dental students	3	-0.31	-0.98	0.36	69	
	Other students	5	0.27	0.06	0.48	14	
	Practitioners	5	0.34	-0.18	0.87	81	
Interactivity[¶]	Virtual patient > Comparison	5	0.62	-0.01	1.24	72	0.96
	Virtual patient = Comparison	11	-0.004	-0.31	0.30	81	
	Virtual patient < Comparison	1	-0.61	-1.22	0.00		
Feedback[¶]	Virtual patient > Comparison	4	0.56	-0.29	1.41	78	0.98
	Virtual patient = Comparison	10	-0.06	-0.29	0.18	68	
	Virtual patient < Comparison	3	0.07	-0.62	0.76	81	
Instructional strategies[¶]	Virtual patient > Comparison	8	0.39	0.05	0.73	83	0.97
	Virtual patient = Comparison	11	-0.17	-0.4	0.06	59	
	Virtual patient < Comparison	2	0.29	-1.20	1.77		
Time spent learning[¶]	Virtual patient > Comparison	1	0.38	0.13	0.62		0.99
	Virtual patient = Comparison	11	-0.06	-0.31	0.19	64	
	Virtual patient < Comparison	1	0.19	-0.11	0.48		
Comparison intervention	Clinical teaching	3	0.58	0.10	1.07	79	
	Human patient simulator (manikin)	1	0.02	-0.35	0.39		
	Paper (handout, textbook, etc.)	4	0.47	-0.03	0.98	72	
	Standardized patient	6	-0.15	-0.56	0.25	80	
	Slide tape	3	-0.31	-0.98	0.36	69	
	Traditional (e.g., lecture)	5	0.14	-0.50	0.77	88	

[*] Knowledge, clinical reasoning, and skill outcomes were merged for these analyses, with higher-order outcomes (skill > reasoning > knowledge) taking precedence when multiple outcomes were reported.

[†] *P* values reflect paired or 3-way comparisons among pre-specified instructional design subgroups. Participant and comparison intervention subgroups are not mutually exclusive, and thus no statistical comparisons are made.

[‡] One no-intervention-comparison study did not report sufficient information to calculate an effect size.

[§] Only four no-intervention-comparison studies presented sufficient information to discern time spent learning.

[¶] We classified studies according to relative between-intervention differences in key instructional methods and features; namely, did the virtual patient intervention have more Virtual patient > Comparison), less (<), or the same (=) amount of interactivity, feedback, instructional strategies, and time spent on learning. Studies for which these features could not be determined are not included in these analyses.

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* Reference numbers in this list will not match those in the reference list of the main text; some but not all publications appear in both lists.