Table 1. Summary Table of Research Studies in Virtual Simulation

Authors & Year	**Study Purpose**	**Research Design & Sampling Strategy**	**Type of Virtual Simulation Used**	**Sample (N) (Characteristics and setting)**	**Data Collection Methods**	**Interventions**	**Major Results/Findings/Learning Outcomes**	**Level of Evidence**
Aebersold, Tschannen, Stephens, Anderson, & Lei, (2012)	Evaluate the student experience using Second Life®	Descriptive, Convenience sample	Second Life®	15 senior-level students in the Midwest US	Researcher-developed surveys using a 5-point Likert-type scale	VS	Overall, students rated the experience as a 3.1 (with a range of 1-5). The most common problems identified were technical difficulties.	**6**
Aebersold, Voepel-Lewis, Cherara, Weber, Khouri, Levine, Tait, (2018)	Evaluate effectiveness of Augmented Reality (AR) to improve psychomotor skills	Mixed methods, Randomized intervention. Convenience sample	Augmented Reality (AR) - iPad anatomy-augmented virtual simulation training module	(N = 69) sophomore and junior nursing students attending a baccalaureate nursing program in USA	21 item check list to assess skill - Nasogastric (NG) tube insertion. All participants completed an on-line Qualtrics survey. AR participants were asked additional open-ended questions about AR. Responses measured on five-point Likert.	AR	Correctly place the NG tube using the checklist items was statistically significant in the AR group compared with the control group ($p = .011$). 86% of participants in the AR group rated AR as superior/far superior, only 5.9% of participants in the control group rated the control program as superior/far superior ($p < .001$). Perceptions of the AR as realistic, easy to use and enjoyable. AR was significantly more helpful in identifying landmarks, visualization of internal structures ($p < .01$) compared with the control.	**2**
Anderson, Page, &	Explore student perceptions of	Descriptive, Convenience sample	Voki classroom	75 second semester sophomore	Instructor-generated surveys using	Avatar-assisted	Most students identified the Voki technology as creating an interesting and enjoyable	**6**

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Wendorf, (2013)	using Voki avatars for case studies in a nursing pharmacology course.			nursing students enrolled in a pharmacology class in Midwest US	a 6-item Likert-type scale and open-ended questions	case studies	learning experience (mean 4.32) that was easy to use (mean 4.48). 92% indicated Voki helped them apply pharmacology content to a realistic patient situation (mean 4.27). Avatars helped socialize them into the role (mean 4.09). Students indicated the technology was engaging, motivating, easy, variety, fun, and interactive. Students were engaged and satisfied.	
Bloomfield, Roberts, &While (2010)	Test whether nursing students could learn and retain the theory and skill of handwashing more effectively when taught using computer-assisted learning compared with conventional face-to-face methods.	RCT	Self-directed Computer Assisted Learning (CAL) module with animated multimedia	242 first year nursing students at a university in the United Kingdom	20-question multiple-choice test; OSCE performance using a 17-item checklist	Completion of the CAL module	Knowledge scores increased significantly from baseline in both groups ($p<0.001$). No significant differences were detected between the scores of the two groups ($p = 0.578$). Skill performance scores were similar at the 2 week follow-up. Significant differences in handwashing skill performance emerged at the 8 week follow-up in favor of the intervention group ($p=0.024$).	**2**

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Borg Sapiano, Sammut, & Trapani (2018)	Examine effectiveness of virtual simulation in improving performance during rapid patient deterioration	Quasi-experimental Convenience sample	Virtual simulation program simulation included three scenarios (Cardiac-Shock-Respiratory)	Undergraduate Nursing students at a university in Malta A total of 166 female (n = 120, 72%). male (n = 46, 28%). 45% 2nd year students (n = 48) and 33% of the diploma third year students (n = 36) participated in the study as compared to 61% of the 2nd year degree (n = 36) and 77% of the third year degree students (n = 46).	Each student completed a knowledge test consisting of 11 multiple choice questions (MCQs) about the assessment and management of acute deterioration, participated in three scenarios of simulated patient deterioration and repeated the same MCQ test	virtual simulation program named FIRST^2 ACTWebTM	A statistically significant improvement in the students' knowledge was observed after carrying out the web-based simulation intervention ($z = -6.506$, $p < 0.001$). The Kruskal Wallis test showed a significant difference between the four student groups in pre-simulation MCQ scores ($p = 0.015$) and post-simulation MCQ scores ($p = 0.034$), suggesting that all the four groups might benefit from the scenarios. All groups scored significantly higher in the respiratory scenario (the last scenario) in the online simulation program, when compared to the other scenarios (χ^2 (3) = 7.727, p = 0.052)	**3**
Broom, Lynch & Preece, (2009)	Explore the student's experience using a virtual ward	Descriptive mixed methods	A virtual ward developed by University of Glamorgan	Sample size not stated. Child health nursing students in the United Kingdom	Focus groups and questionnaires	2 VS	87% agreed or strongly agreed the computer simulation provides a suitable experience for learning this skill. 100% felt undertaking the simulation helped me apply knowledge to practice. Focus groups yielded themes of Developing Knowledge, Helping with Clinical	**6**

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							Practice, and They are not the Real Thing.	
Bryant, Miller, & Henderson, (2015)	Examine the effects of participation in a VCS on health assessment skills/ clinical proficiency and evaluate the VCS as a teaching strategy.	Quasi-experimental and convenience sample	Digital Clinical Experience ™	60 Family Nurse Practitioner students at a Midwestern US University	Integrated Performance Proficiency Rating Tool Adaptations of the National League for Nursing Simulation Design Scale, Educational Practices in Simulation Scale, and Student Satisfaction and Self-Confidence in Learning.	Virtual clinical simulations	No significant difference was revealed in course grades, integrated performance proficiency scores, or in National League of Nursing simulation scores.	**3**
Burke (2016)	Describe the process / outcomes of integrating virtual interactive patient case studies into the clinical courses of an online pediatric nurse	Descriptive Convenience sample	Computer-based diagnostic decision simulation case studies by I-Human Patients®	convenience nonprobability sample of forty-three Pediatric Nurse Practitioner students in an online synchronous graduate program in US	Cases graded based on a product standardized grading rubric Journaling experience = ten open ended questions related to the	Computer based Simulation Case Studies	Significant improvement in all three critical areas of clinical decision making. Statistically higher mean scores from clinical courses. Virtual interactive case studies allow students to master these skills through active engagement in objective evidence-based patient interactions. Students commented that the	**6**

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	practitioner program.				simulation activities. Journal responses analyzed using content analysis.		interactive case studies helped develop their logical reasoning and creativity.	
Carlson-Sabelli, Giddens, Fogg & Fiedler (2011)	Explore the primary benefits and challenges reported by learners using a virtual community. Examine the relationship between perceived learner benefits and challenges.	Mixed-methods	*The Neighbor-hood*	*N* = 281 nursing students from 5 sites in the US	19-item exit survey representing four constructs (perceived learning utility, perceived benefits and challenges, learner engagement, and cultural awareness) using a 0 to 10 scale.	Compar e a no use group, low-use group, and high-use group	The high-use group had higher mean benefits and challenges scores (*M* = 4.57, *SD* = 2.45 compared to the low-use group (*M* = 2.88, *SD* = 2.27), *p* = 0.00. Themes were 1) an Enlarged View of factors that impact health care, 2) Clarity of Concept Application to real-life situations, and 3) Engagement in which characters and their situations become alive through ongoing stories. Perceived student benefit is impacted by frequency of use.	**3**
Carman et al., (2017)	Describe the use of virtual simulation in a distance-based Acute Care Nurse Practitioner (ACNP) program and student	Descriptive Convenience Sample	iSimulate	23 nurse practitioner students enrolled in the US	The evaluation tools assessed 8 areas of performance performed by students in the simulation. 14 recordings	3 virtual simulati ons	More than 80% of the student groups performed the key behaviors.	**6**

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	performance in the simulations				assessed to review ACNP performance.			
Caylor, Aebersold, Lapham, & Carlson, (2015)	Examine the use and effectiveness of Second Life in Multiprofessional learning.	Pre-posttest design, convenience sample	Second Life®	*N* = 21 students; Nursing students (*n*=8), pharmacy students (*n*=7), medical students (*n*=7) at a Midwestern US University	Interdisciplinary Education Perception Scale, Team-STEPPS Teamwork Attitudes Questionnaire, Team Performance Observation Tool, Technology and Overall Experience Survey	Virtual simulation	Teamwork Attitudes demonstrated improvements for all groups. Students identified that Second Life reduced stress levels related to simulation and multiprofessional activities. Technical difficulties were noted.	**3**
Chia, (2013)	Examine nursing students' perception and experience of using a virtual game prior to the related simulation based learning activity	Descriptive study, Convenience sample	COPD virtual game developed by the author. Students participate in the game prior to their simulation based learning activity in	161 year 2 diploma in nursing students in Singapore	Questionnaire about their perception and experiences of the virtual game	n/a	99% found the virtual game relevant to their learning needs. 94% found the game interesting. Comments including "the game is interesting and fun, "new experience in learning" and "the graphics are very engaging." P. 23. "knowledge gained with regards to the nurse's role in managing a COPD patient." P. 23 Feedback included "more challenging questions for us to learn" and "option to	**6**

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			the simulation laboratory.				choose a more complex level of the game to increase sense of achievement."	
Cobbett & Snelgrove-Clarke, (2016)	Compare the effectiveness of two maternal newborn clinical simulation scenarios: virtual clinical simulation and face-to-face high fidelity manikin simulation	Experimental, convenience	vSim for Nursing®	56 third year BSN students in Canada	Nursing Anxiety and Self-Confidence with Clinical Decision Making Scale, knowledge pre and posttest related to preeclampsia and group B strep, and Simulation Completion Questionnaire	2 virtual simulations and a face-to-face high fidelity manikin-based simulation	There were no statistically significant differences in student knowledge and self-confidence between face-to-face and virtual clinical simulations. Anxiety scores were higher for students in the virtual clinical simulation group (p=0.002). Over 90% of participants preferred face-to-face simulation. Technological issues were reasons most often cited for not liking the virtual clinical simulation.	**2**
Cook, McAloon, O'Neill, & Beggs (2012)	Evaluate the impact of an interactive web based simulation gaming platform on student nurses' performance in life support training	Mixed methods: Experimental and descriptive qualitative, convenience	PULSE using Adobe® Flash	34 final year undergraduate nursing students in the United Kingdom	Faculty-developed scoring sheet from 1-5. Online surveys.	Web-based simulation	No significant differences were obtained in the assessment stations of using ABCDE and correct performance of chest compressions. Statistically significant differences were found in the stations of checking equipment, airway assessment and the safe/effective use of defibrillator (p<0.05) indicating that PULSE improved performance in these three skillsets.	**2**

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							Qualitative comments indicated themes of: helpful aid, opportunity for repetition, helped understanding, and technical issues.	
Cooper, et al, (2015)	Evaluate performance outcomes and participant evaluations in relation to the feasibility of face-to-face simulation and e-simulation.	Mixed methods: Quasi-experimental and descriptive qualitative	FIRST^{2}ACTWeb™	444 final-year preregistration nursing students in three Australian universities and and 45 students in two vocational colleges	Knowledge Test, OSCE checklist, Skill ratings using a 5-point scale, and a course quality evaluation from 1-5 with open-ended questions.	e-simulation program	Clinical knowledge improved in both groups. Clinical performance was moderate for both groups, knowledge, confidence, and competence significantly improved for both groups (p=.000). The e-simulation had a small to medium effect on knowledge improvement and skill gain was perceived as highly valuable for learning. The face-to-face approach was more positively regarded than Web-based simulation (p=.000) because of the reflective debriefing. Themes included: Translation of theory into practice, be systematic, a good way to learn, teamwork, collaboration, simulating a real emergency, practice builds confidence, and the simulation model. Course quality evaluations were positive for both groups.	**3**
Durmaz, Dicle, Cakan, &	Examine the effect of screen-based computer	RCT	Web-based, Screen-Based Computer	82 second-year undergraduate nursing	Preoperative and postoperative care	One SBCS	There was not a significant difference between the students' posteducation knowledge levels (p= .421),	**2**

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Cakir, (2012)	simulation on knowledge, skill, and the clinical decision-making process in teaching pre-operative and postoperative care management		Simulation (SBCS)	students in the west of Turkey	management cognitive level assessment test – 50 multiple choice questions, skill control lists of preoperative and posteroperative care management, and the Clinical Decision Making in Nursing Scale.		practical deep breathing and coughing exercise education skills (p= .867), or clinical decision-making scale total and subscale scores (p=.065). A significant difference was found between the admission of the patient in the surgical clinic after surgery skill scores of the students (p= .04). Education provided in the screen-based computer simulation laboratory was equivalent to that provided in the skill laboratory.	
Engum, Jeffries, & Fisher, (2003)	Compare the effectiveness of an interactive, multimedia, virtual reality computer IV catheter simulator with a traditional laboratory experience of teaching IV venipuncture skills	RCT	CathSim	163 participants, 70 baccalaureate nursing students and 93 third-year medical students US	Pre / post instructional 20-item evaluation completed before and after simulated encounter. Ability to perform skill tested with a 21-item, 29 point weighted	Computer catheter simulator program utilizing virtual reality (CathSim).	Significant improvement in cognitive gains, student satisfaction, and documentation of the procedure with the traditional laboratory group compared with the computer catheter simulator group. Both groups were similar in their ability to demonstrate the skill correctly. Nursing students: traditional method had significantly higher satisfaction scores (P = 0.0002) with the mean scores	**2**

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					competency checklist. *Satisfaction* evaluated using a five-item subscale / 5-point Likert response *Self-efficacy/self-reliance questionnaire* self-efficacy/self-reliance evaluated using a six-item subscale with a 5-point Likert response.		for traditional, 15.22 and 11.24 for the CathSim group (Cronbach's alpha = 0.93). Self-efficacy/reliance scores were significantly higher (P = 0.0167) for the traditional method of learning (mean 23.11) when compared with CathSim (mean 20.03 [Cronbach's alpha = 0.89]). The pretest scores for both groups were similar, but the posttest and improvement scores were significantly better (P = 0.0064, P = 0.01, respectively) for the traditional group (mean 16.54) in comparison to the CathSim group (mean 15.00). Venipuncture scores and accuracy were similar for both study groups.	
Evans & Curtis, (2011)	Evaluate students' perceptions related to the effectiveness of a Second Life experience to teach conflict management	Descriptive mixed methods	Second Life®	20 senior pre-licensure nursing students in the Southeastern US	Likert type surveys from 1 (strongly disagree) to 5 (strongly agree) and self-reflections	One conflict simulation	72% of respondents indicated they were more comfortable exploring conflict in the virtual environment than they would have been if scenarios had been face-to-face. 89% indicated they were able to effectively apply conflict management strategies. 95% shared the scenarios	**6**

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							represented real=life lateral violence situations. Comments were positive such as "I enjoyed it."	
Farra, Miller, Timm, & Schafer, (2013)	Examine the effects of virtual reality simulation (VRS) on learning outcomes and retention of disaster training.	Longitudinal, experimental design, convenience sample	Second Life®	47 2nd year associate degree nursing students enrolled in their final nursing courses at a community college in the Midwestern US.	20 question multiple choice knowledge assessment pre/post and 2 months following training.	Second Life simulation with web-based teaching compared to standard of web-based teaching only	VRS had a strong positive effect on retention of disaster training. The main effect of the virtual simulation was strongly significant (p<.0001). The VRS effect demonstrated stability over time. CRS is an instructional method that reinforces learning and improves learning retention.	**2**
Farra, et al., (2015)	Examine use of virtual reality simulation (VRS) to teach the disaster-specific skill of decontamination.	Quasi-experimental design, Convenience sample	Microsoft Kinect ™ decontamination game	106 senior nursing students from 2 Midwestern US universities.	Emergency Preparedness Information Questionnaire (EPIC), FEMA IS-346, Decontamination Checklist	VRS compared to the standard of a one-page written description of the skill	Although students in the treatment group had significantly lower performance scores than the control group (p=0.004) students taking part in VRS completed the skill in a significantly shorter amount of time (p=0.008). No significant group differences were found for self-efficacy (p=0.172) or knowledge (p=0.631). However, students in the VRS treatment group reported high levels of	**2**

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							satisfaction with VRS as a training method.	
Fernández Alemán, Carillo de Gea, & Rodríguez Mondéjar, (2011)	Compare the effects of competitive e-learning versus conventional teaching methods on acquisition and retention of knowledge	Randomized control design	Mooshak, a free and publicly available web tool was adapted to include videos and multiple choice questions	116 students in a second-year medical-surgical nursing course in Spain.	Multiple choice questions (Medical surgical nursing knowledge scores) Satisfaction scores on 0-10 Likert type scale	VS for 10 weeks	Competitive e-learning produced significant cognitive gains for the experimental group in the immediate follow-up test (p=0.007). Both teaching methods resulted in similar knowledge retention in the 10-week follow up test. Means satisfaction scores were 7.96 out of 0-10. 100% reported they preferred to work at home using Mooshak.	**2**
Foronda, et al., (2016)	Report students experience with vSim for Nursing™	Mixed methods: Descriptive quantitative and qualitative, Convenience sample	vSim for Nursing™	54 accelerated BSN students in the MidAtlantic US	Instructor-developed survey using Likert-type scale of 1-4.	2 virtual simulations	98% of students reported the VS was easy to use. 98% of students recommended the virtual simulation for future use. Several students indicated frustration with rea-time features such as handwashing and the inability to multi-task.	**6**
Foronda, Budhathoki & Salani, (2014)	Evaluate the intervention of virtual simulation (VS) to teach leadership styles to master's in nursing	Pre-posttest design, Convenience sample	CliniSpace ™	8 master's-level nursing students in Southeastern US	20-item, multiple choice exam about leadership styles	VS	Students' pretest scores ranged from 45 to 85, with a mean score of 64.4 (SD 14.88). The median score was 62.5. Post-test scores ranged from 65 to 100, with a mean score of 84 (SD 11.11). Students demonstrated a statistically significant	**3**

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	education students						improvement of 19.3 points, a 30% improvement over the baseline measure (p = .012). The students demonstrated an improvement in cognitive knowledge after the virtual simulation exercise.	
Foronda, Gattamorta, Snowden, & Bauman, (2014)	Evaluate the educational innovation of virtual simulation (VS) to improve communication skills of BSN students.	Within-group, time-series design, Convenience sample	CliniSpace ™	8 BSN students in Southeastern US	CliniSpace ISBAR Rating Sheet	VS	Mean group student performance scores more than doubled from performance one to performance two (p<.001). Students expressed having less anxiety, knowing what to expect, and having "better flow" with communication. Students verbalized learning to assess the patient prior to calling the physician and to give a recommendation to the physician.	**3**
Foronda, Lippincott, & Gattamorta, (2014)	Evaluate nurse educator students' experience with virtual simulation and the effect of virtual simulation on confidence in teaching ability.	Mixed methods, convenience sample	CliniSpace ™	43 Master of Science in Nursing students in Southeastern US	Adapted Nursing Clinical Teaching Effectiveness Inventory Focus groups and debriefing sessions	VS	Aggregated quantitative results yielded no significant change in confidence in teaching ability. Individually, some students indicated change of either increased or decreased confidence, whereas others exhibited no change in confidence after engaging in VS. Qualitative findings revealed a process of precursors	**3**

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							of anxiety and frustration with technical difficulties followed by outcomes of appreciation and learning. Instructor support was a mediating factor to decrease anxiety and technical difficulties.	
Foronda, Hudson, & Budhatho-ki, (2017)	Examine the impact of an in-class, group VS exercise on nursing students' a) cognitive knowledge of EBP and b) affective knowledge about how evidence affects clinical decision-making.	Pre-posttest design, Convenience sample	CliniSpace ™	108 prelicensure, master's entry-level nursing students in the MidAtlantic US	Objective, multiple choice test questions (faculty developed survey)	VS	Cognitive knowledge scores significantly improved ($p <$ .0001). Scores related to valuing EBP (affective knowledge) also increased.	**3**
Foronda, Swoboda, Henry, Kamau, Sullivan, & Hudson (2018)	To explore the preferences and perceived learning outcomes of pre-licensure nursing students who engaged in a virtual simulation	Mixed-methods, quantitative descriptive and qualitative descriptive; convenience sample	vSim for Nursing™	99 accelerated BSN students in the Mid-Atlantic US	Survey developed by two nurse researchers experienced in simulation; Likert-style questions ranked 1(strongly disagree) to 5 (strongly	VS	49% of students agreed vSim was easy to navigate; 89% agreed content was relevant to their role as a nurse; 78% would recommend vSim for future use; 6% responded they purposely chose wrong intervention to see what would happen; 77% found vSim to be effective/realistic; 51% responded vSim would be most useful as make-up for	**6**

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					agree), yes/no questions, rank where vSim for Nursing would be useful in curriculum, and open ended final statement/comments about vSim		missed clinical hours, 29% in place of case study for lecture, 12% as homework, and 5% in place of mannequin-based simulation; three themes emerged regarding student's key points of learning (1) assessment (2) prioritization, and (3) emergency management.	
Forsberg, Georg, Ziegart, Fors, (2011)	Investigate nursing students' opinions about the feasibility of using Virtual Patients (VP) for assessing clinical reasoning in nursing education.	Descriptive mixed methods	Web-SP Virtual Patient system	77 nursing students in 2 universities in Sweden	Faculty developed survey from 1(do not agree) to 6 (totally agree).	Several virtual cases	Students found the VP's to be realistic and engaging, and indicate a high level of acceptance for this assessment method. Students' opinion scores ranged from 4-6 on the virtual cases for assessment. Scores ranged from 3-5 on the use of the Web-SP system. Advantages included that the cases were realistic. Disadvantages included difficulty in navigation. "It was hard to figure out how to do certain things" and "it was difficult to find the actual illness history question you wanted to ask" (p. 761).	**6**
Fowler, et al., (2018)	Assess effectiveness/impact of Virtual Interprofession	Convenience sample Cohort study	VIP (created for this study)	Two student cohorts (n = 36 and n = 24, N = 60) over 4 weeks. Both	The first cohort of 36 completed the case scenario (VIP),	VIP learning platform	**Cohort 1: Feasibility Assessment** Students overwhelmingly found the case to be realistic and believed the scenario	**4**

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	al (VIP) Learning			cohorts were the Colleges of Medicine, Nursing (RN-to-Doctor of Nursing Practice program), and Pharmacy and divided into IP teams US	followed by in-person focus groups and an online self-administered usability survey. The team refined the platform r/t findings, and then pilot tested the platform with a second cohort of 24 students. Focus groups *Survey Method:* Website Analysis and Measurement Inventory (WAMMI The Interprofessional Collaborative Competency (IPCC) Scale administered to the second		enhanced their understanding of real-life situations **Cohort 2: Pilot Testing** Consistent with the first cohort, participants in the second cohort found the VIP Learning platform to be a useful tool with engaging content on root cause analysis. Students reported feeling enjoyment in working with students from other professions and found VIP Learning to be a safe, engaging environment for learning. There was a significant pre- to posttest improvement in participants' fulfillment of one's role as a professional; all four items in this subscale showed significant or borderline significant (p = .05) improvement. Five of the eight items on the attitudes that improve team cohesion subscale demonstrated pre- to posttest improvement, but only one item on the attitudes that improve team cohesion subscale was significantly different pretest versus posttest.	

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					cohort of students before and after participation in the VIP.			
Gerdpras ertPruksa chev-a, Panijpan, & Ruenwon g-sa (2010).	Evaluate a web-based learning media on the process and mechanism of labour	Mixed methods (quasi-experimental and interviews)	Web-based unit on the mechanism of labour	85 third-year nursing students in midwifery in Thailand	Factual knowledge test (20 multiple choice, 20 true/false, and 28 interactive questions), Students' perception survey (20-items using a 5-point Likert scale (1 strongly disagree to 5 strongly agree), and interviews.	Web-based unit ranging from .33-8.17 hours	The experimental group had significantly higher scores in factual knowledge than the control group (p<0.001). The student perception scores indicated high satisfaction and quality of the web-based learning medium. Students found the unit useful and that they could easily learn from it (4.45 ± .42). Students found it easy to navigate (4.42 ± .54), appropriate for online learning (4.33±.69) and preferred the web-based course when compared to textbooks (4.12±.70). Posttest scores were correlated with those of the website access time (r = .777, p < .001). Website access time was correlated with satisfaction scores (r=.756, p<.001). Comments included, "It is a very useful learning method", "I can study at home, at any time", and "they help my understanding more than just reading from the textbooks." Negative comments included,	**3**

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							" I may not get the exact answers" and "a detailed instruction on how to use the web-board should be included" (p.468).	
Giddens, Fogg, & Carlson-Sabelli, (2010)	Examine variables associated with student-perceived benefits and utility among undergraduate nursing students using a virtual community	Correlational design	*The Neighborhood* virtual community	350 student participants enrolled in 5 baccalaureate programs across the US using a virtual community	19-item exist survey with questions regarding participants' personal experiences as users of *The Neighborhood*	Use of the virtual community	The relationship between the use of the virtual community and perceived benefits among learners was substantial (r = .416, p = 0.000). Utility scores were higher among white/Asian students compared with minority students (t =.219, df = 330, p =.03). Engagement was greater among minority students than white/Asian reporting program use (p=0.05). The perceived benefits of a virtual community are impacted by the frequency of program use.	**4**
Giddens, Shuster, & Roehrig, (2010)	Assess the initial perceived benefits of using a virtual community known as *The Neighborhood* in a single undergraduate baccalaureate nursing program a few	Descriptive and comparative study, convenience	*The Neighborhood* virtual community	N = 248 undergraduate baccalaureate nursing students in a southwestern university in the US	Faculty-developed surveys with 8 questions using a Likert type scale from 1 (low) to 5 (high) with a score range of 0 to 40.	Use of the virtual community	Older students (24 and older) had greater preferences overall. There was no difference in preferences between students with previous degrees or between men and women. The group expecting lower than an A reported more benefits from the virtual community (p = 0.041) and a greater perception that it helped them by connecting character problems to course concepts	**6**

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	years after development.						(p = 0.03). Minority students reported more benefits overall.	
Giddens, Hrabe, Carlson-Sabelli, Fogg, & North (2012)	Evaluate the effectiveness of a virtual community on student engagement and academic performance	Quasi-experimental	*The Neighborhood* virtual community	120 first-semester baccalaureate nursing students in the Southwest US	Classroom observation of learner engagement, End-of-class student survey using a 5-point Likert type scale (1-very low; 5 = very high), Examination items through multiple-choice questions	*The Neighborhood* virtual community	Students in the experimental group appeared more engaged more often. During 2 of 4 class sessions, students in the experimental group reported significantly ($p < 0.01$) greater engagement on the end-of-class survey. There was little difference between groups on quality of instruction. There were no significant differences in academic performance (on test scores) between the two groups.	**3**
Giddens, North, Carlson-Sabelli, Rogers, & Fogg (2012)	Assess the use of a virtual community as a teaching application to foster cultural awareness among nursing students	Correlational design	*The Neighborhood* virtual community	342 first-semester nursing students from 5 baccalaureate nursing programs across the US that used *The Neighborhood* virtual community	Exit survey with 22 questions including open-ended responses. 3 items formed the cultural awareness scale using a 1-5 Likert-type scale.	*The Neighborhood* virtual community over one semester	There was a significant correlation between frequency of use and cultural awareness (r=.246; p <.000) Virtual communities may represent a useful teaching application for cultural competence in nursing education.	**4**
Gobbi, et al. (2004)	Examine if skill acquisition is enhanced	Quasi-experimental	Virtual Interactive Practice™ - Virtual	18 nursing students in the United Kingdom	Current and retrospective self-report ratings,	5 days in the virtual ward	Only preliminary results are presented. From the self-report assessments of the student competencies in the	**3**

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	when virtual and interactive strategies are used to facilitate competence based learning.		Children's Ward named Badger Ward (linking digital images, video, breath/heart sounds, and clinical data)	approaching the end of their programme	satisfaction scores, Surveys used a 5 point-Likert type scale with 5 being the best. The five domains were communication and interpersonal skills; ethical and professional development; fundamental of nursing practice; health education and promotion skills; management and decision making skills.		five domains and 29 sub-competencies, 15 of the 29 demonstrated statistically significant improvements in competence levels. These were spread across all five domains. Overall mean satisfaction scores were 4.18. 87.5% of students judged the content was "just right."	
Gu, Zou, & Chen, 2017	Evaluate vSim's effect on performance of nursing students.	Randomized, controlled, posttest design	vSim for Nursing™	28 undergraduate (2nd year) nursing students in China	Cognitive knowledge test and two nursing skill performances	VS	The scores of the knowledge tests in the experimental group (M = 73.31, SD = 9.27) were significantly higher than those in the control group (M = 65.36, SD = 8.93), t = 2.27, p = .032). The scores of the two nursing skills performance in the experimental group were	**2**

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							greater compared with the control group, although, without statistical significance.	
Haerling, (2018)	To compare cognitive, affective, and psychomotor learning outcomes between students using mannequin-based simulation and students using virtual simulation; to describe a cost-utility analysis comparing the two types of simulation	Mixed-methods - Quasi-experimental nonequivalent comparison group design + qualitative; convenience sample	vSim	84 associate degree nursing students, 81 completed all the quantitative assessments in US	Knowledge exam about simulation content; NLN Student Satisfaction and Self-Confidence Learning (SSC) survey; documentation of assessment, written hand-off report; reflection questions– scored using the Lasater Clinical Judgment Rubric (LCJR) and the Creighton Simulation Evaluation Instrument (C-SEI)	VS-video-recorded standardized patient encounter	Post-intervention knowledge scores in both groups was significantly improved (p <.05); SSC scores were significantly higher post-intervention for both groups; no significant difference in standardized patient performance scores between the mannequin-based or the VS groups; 3 themes emerged in participants' from both groups reflection about what they would differently if they were to repeat the same simulation (1) safety (2) communication (3) prioritization/time management; VS students expressed intent to focus on safety if they repeated the simulation and mannequin-based students to focus on communication; students in the VS group reflected technology troubles and students in the mannequin-group expressed frustration with finding materials Mannequin-based simulation instrumental costs were	**3**

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							$36.55/student and VS costs were $10.89/student; overall cost/utility ratio for mannequin-based simulation was $3.62 vs. $1.08 for VS.	
Ismailoglu & Zaybak, (2018)	To compare the use of virtual IV simulator (VIS) with a plastic arm model for teaching IV insertion skills	Randomized controlled trial; convenience sampling & stratified sampling	Virtual IV Simulator (VIS)	32 bachelor's degree nursing students in Izmir, Turkey	15-item IV knowledge test developed by researcher; 20-item IV catheterization skills checklist created by researcher; visual analog scale (VAS) for both students' self-confidence and satisfaction with teaching method; 17-item Fear Symptoms Scale	VR	No difference between experimental and control groups in pretest and posttest knowledge; mean psychomotor skills score was significantly higher (p = .000) in the VS group (M = 45.18) than in the control (plastic arm) group (M = 20.44); students in the experimental group were more satisfied than in the control group (p = .000); no significant difference between groups in self-confidence or mean clinical psychomotor skills score (M = 16.28 for experimental vs. M = 15.63 for control); scores for the following fear symptoms were higher in the control group than the experimental group: (a) cold and sweaty hands (p = .026), (b) significant restlessness (p = .047), and (c) tense muscles (p = .036)	**2**
Jeffries (2001)	Compare the effectiveness of an interactive,	Randomized pretest/posttest experimental design,	CD ROM developed by Dr. Jeffries	42 junior BSN students at a university in	11-item student satisfaction scale adopted	Lecture and video vs.	There were significant differences between the two groups in cognitive gains and student satisfaction with the	**2**

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	multimedia CD-ROM and a traditional lecture for teaching oral medication administration to nursing students.	convenience sample		the Midwestern US	from items of the Flashlight Project Current Student Inventory (Ehrmann, 1995). Faculty-developed 40-item pretest and posttest and a skills competency checklist.	multimedia CD-ROM program	computer group demonstrating higher cognitive gains ($p = 0.05$) and student satisfaction ($p = 0.01$) than the lecture group. The computer group had a posttest mean of 95.7% correct and the lecture group had a posttest mean of 84.7% correct. There were no differences on their competency in administering oral medications. Time on task was 31% less for the computer group.	
Johannesson, Olsson, Petersson, & Silén, (2010)	Investigate the learning gained from computer simulation skills training. health nursing students	Descriptive design, convenience sample	CathSim®	22 undergraduate (second year) nursing students in Sweden	Three questionnaires developed by faculty members	CathSim®	Eight of 20 students regarded themselves as being sufficiently prepared for intravenous catheterization. Students mentioned haptic feedback and being aware of variations were valuable learning features. Students mentioned, "becoming more assured without practicing on a patient" and "getting into a routine and exercising the practical training" (p. 271).	**6**
Johnsen, Fossum, Vivekananda-Schmidt, Fruhling, &	To describe the design, development, and usability of a video based serious game (SG) for	Mixed-methods - quantitative and qualitative descriptive design; convenience sample	Serious game developed for this study – RN taking part in a home	6 participants – 2 nursing students, 2 university lecturers, and 2 home health RNs in Norway	Cognitive walkthrough - recorded user's thoughts (instructed to vocalize	Serious game – computer-based simulation	Most participants (median score = 6) agreed they could efficiently complete the tasks/scenarios; responses varied to if the organization of information on the screens were clear (range 4-6, median	**6**

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Slettebo, (2016)	teaching clinical reasoning and decision-making skills to nursing students who are caring for patients with COPD in home healthcare settings		health visit for a patient with COPD		difficulties/thoughts or questions) to explore usability; modified Post-Study System Usability Questionnaire (PSSUQ) to include TURF (task, users, representation, and function) framework using Likert scale (1 = strongly disagree, 7 = strongly agree); semi-structured follow-up interview to assess satisfaction and recommendations for improvement		= 5), and if the information was easy to find when they needed it (range 3-7, median = 6); most participants thought the SG was simple and comfortable; most agreed they were satisfied with the SG (median =6); both teacher participants thought the SG was effective for teaching students and it would be a good supplement to training in lab/clinicals, but one teacher found the game to be tedious and suggested the scenario could be more "to the point"; students agreed the SG would have been useful to play prior to clinicals; all participants (n = 7) found the SG content to be relevant for use in nursing education; all agreed the tasks/questions had an adequate level of complexity and expressed it was realistic from the domain of home healthcare; several usability issues identified such as length of videos, lack of ability to skip back and forth, layout, inability to undo drag-and-drop tasks, etc.	
Kaveevivit-chai, Chuengk	Evaluate the effect of computer-	Mixed methods: RCT and interviews	CAL multimedia using	117 second-year nursing students	Factual knowledge test on VS	90 minute CAL	Each group showed a significant gain in knowledge. There was no significant	**2**

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ri-ankrai, Luecha, Thanooruk, Panijpan, & Ruenwong-sa (2009)	assisted learning (CAL) on nursing students' attitudes and knowledge of vital signs.	Arm 1 – Lecture/CAL Arm 2 – Lecture/CAL/Demonstration Arm 3 – Lecture/Demonstration	graphics, pictures, animation, video and simulation of experiences.	enrolled in a fundamental nursing course from two schools in Thailand.	(30-item multiple choice test); Performance checklist (29-items with points ranging from 0-4); Students' attitudes were measured by the CAL assessment scale and interviews		difference in factual knowledge among CAL supplemented groups and the traditional group ($p>.05$). The performance checklist scores of the CAL supplemented groups were significantly higher ($p<.001$). Students' mean satisfaction score was 91.20 ±9.18 (out of 100) indicating high satisfaction and quality of CAL from the user's perception. Categories emerged of "Learner", "learning environment" and "software designs." Comments included, "increases understanding", "more interesting and colorful", "enhances the learner's experience and understanding" and "provides an independent interactive learning experience." (p. 71.) The only complaint was that students wanted more time with CAL.	
Kidd, Knisley, & Morgan, (2012)	Assess the effectiveness of Second Life as a teaching strategy for undergraduate mental health nursing students.	Descriptive, convenience	Second Life®	126 undergraduate nursing students in the Midwest, US	Second Life Simulation Evaluation Survey (researcher-developed survey)	Second Life®	Participants found the simulation to be a moderately effective teaching strategy and a slightly difficult technical program. A significant relationship was found between age of computer and educational effectiveness ($r = 0.188$, $p <$	**6**

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							0.05). Technical difficulties were expressed as one student mentioned, "I was too rushed and could not multi-task quick enough" (p. 35).	
Kiegaldie & White, (2006)	Develop, implement, and evaluate *The Virtual Patient*.	Mixed methods; Descriptive quantitative and qualitative	*The Virtual Patient*, an interactive multimedia learning resource	26 students enrolled in post-graduate nursing courses in Australia in two campuses	Questionnaires and focus groups	VS	Themes emerged of "Workplace Authenticity and Relevance of the CD-ROM, Clinical Problem-Solving Ability, Participation in Collaborative Learning, and Technological Access. Comments included, "very realistic sounds and images – kept you interested and stimulated" (p.40). 83% reported VS had improved their confidence and skills in being able to systematically interpret assessment findings and define a clear plan of action. 54% of students reported technical difficulties.	**6**
Kleinhek sel (2014)	Examine relationships between student reflection scores and the digital clinical experience.	Within-stage, mixed-model design, secondary data analysis, convenience	Digital Clinical Experience ™	130 master of science in nursing students in US	Reflection Rating Rubric Clinical Reasoning and Implications for Practice self-reflections	VS	The most significant predictor of the Implications for Practice reflection score was Critical Items discovered (β= 0.903 and ($p <$ .001). Minutes spent was a significant predictor of critical items and red flag items discovered (β=0.706 and p=.004). The results of this study indicate that the number of Critical Items discovered had a strong positive	**4**

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							correlation with the Implications for Practice reflection score.	
LeFlore, et al., (2012)	Compare the achievement of learning outcomes of undergraduate nursing students when a virtual patient trainer or traditional lecture was used to teach pediatric respiratory content	Randomized, controlled, posttest design.	Researcher-developed Virtual Pediatric Patients (VPP) and Virtual Pediatric Unit (VPU)	93 senior BSN students enrolled in a pediatric nursing course in one university in the Southern US	OSCEs and 10-item multiple-choice written test	Two Virtual Patient Experiences	There was a significant difference in knowledge acquisition between the control and experimental groups (mean 75±12 vs. 83.9 ± 15, $P = 0.004$). On the checklists for the two OSCEs measuring knowledge application, there were significant differences in times between the groups for all critical elements, with the experimental group demonstrating more timely performance of critical nursing tasks (P=0.001 for each of the two scenarios).	**2**
Liaw, Chan, Chen, Hooi, & Siau (2014)	Evaluate the efficacy of virtual patient simulation by comparing to manikin-based simulation for improving nursing students' performances in assessing and managing patients with	RCT – evaluations were conducted one day after and 2.5 months after the intervention	e-RAPIDS	57 third-year nursing students in Singapore	Manikin-based simulation assessment RAPIDS tool Adapted e-learning systems success scale Surveys	2 hour virtual patient simulation compared to 2 hour manikin based simulation	Both experimental and control groups demonstrated significant improvements (p<.001) in first and second posttest scores. The scores between groups did not differ significantly over time (p=.17). The virtual patient simulation was rated positively.	**2**

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	clinical deterioration.							
McCallum, Ness, & Price, (2011)	Explore nursing students' decision-making skills through the use of Second Life	Exploratory, qualitative evaluation	Second Life®	5 third-year student nurses in the United Kingdom	Written communication text from the scenario; semi-structured interviews using open questions.	1 hour simulation caring for 6 patients	The majority of decisions (*n*=21) were made in response to a situation or patient request and were reactive rather than pro-active (*n*=9). Interviews produced themes of 1) Performing decision-making and 2) Improving learning.	**6**
Menzel, Willson, & Doolen (2014)	Examine whether an interactive virtual poverty simulation would improve nursing students' empathy with and attributions for people living in poverty, compared to a self-study module.	RCT	Second Life®	51 baccalaureate nursing students in US	Attitude Toward Poverty Scale	2.5 hour Virtual poverty simulation offered 3 times in 1 year	There were no differences on the total score on the Scale between control and intervention groups. The active learning approach of VS produced more positive changes in attitudes about poverty than a passive learning approach on several items. VS did not significantly increase student recognition of the association between poverty and health compared to a passive learning approach. Whereas students readily learned how to navigate inside Second Life®, faculty facilitators required periodic coaching and guidance to be compe-tent. Faculty must incorporate social justice concepts throughout the curriculum to produce lasting change.	**2**

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Merritt, Brauch, Bender, Kochuk, & (2018)	To develop and implement a Web-based, e-Visit simulation experience for nurse practitioner (NP) students and evaluate student satisfaction and perceived learning	Descriptive design; convenience sample	Virtual e-Visit simulation developed by NP faculty	26 NP students (pediatric and adult-gero) in a public Midwestern university in US	Likert (1 = strongly disagree to 5 = strongly agree) survey evaluating the learning experiences	VS	97% of the students thought the simulation cases closely resembled real-world patients (*M* = 4.42, *S* = 0.69); 81% thought it provided them with a better understanding of the APRN's role in telehealth services (*M* = 4.27, *SD* = 0.94); 92% of students reported the exercise enable them to perform an assessment (*M* = 4.50, *SD* = 0.64) and formulate a diagnosis (*M* = 4.38, *SD* = 0.74); accuracy of diagnosis and treatment on the first attempt was 95%; 96% of students thought their understanding of complaints commonly addressed via telehealth had increased (*M* = 4.46, *SD* = 0.57)	**6**
Mosalanejad, Shahsavari, Sobhanan, Dastpak, (2012)	Determine the effectiveness of virtual systems on competency-based skills of first-year nursing students.	Quasi-experimental, cluster	"virtual animations" developed by the instructor	86 freshman and sophomore nursing students in Iran	Multiple choice exam Objective structured clinical examination (OSCE) performance	VS	The virtual teaching group scored significantly higher on the exam than the traditional group ($p<0.001$).There was no significant difference between the two groups on the practice indicator of the objective structured clinical examination. A combination of both traditional and virtual teaching methods are recommended.	**3**

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Padilha, Machado, Ribeiro, Ramos, & (2018)	To assess the ease, usefulness, and intention of pre-graduate nursing students to use a clinical virtual simulator	Descriptive and correlational design; convenience sample	Body Interact™ - a clinical virtual simulator (CVS)	426 nursing students in Portugal	8-item questionnaire developed based on the Technology Acceptance Model (TAM) utilizing a10-point Likert scale (1 = lower score)	VS	Students with no clinical experience perceived more ease (p = .008), usefulness (p = .003), and intention (p = .005) to use the CVS than students with clinical experience; students showed an average score of 9.55 (SD = 0.73) in perceived relevance of CVS in their learning process and of 9.71 (SD = 0.59) when asked about CVS acting as a facilitator of their learning as nursing students; female students showed higher values in perceived usefulness and intention to use the CVS than the male students (p = .024); there was a small, negative correlation found between age and perceived usefulness/intention to use CVS (r_s 426 = -.104, p = .05)	**4**
Pittiglio, Harris, & Mili, (2011)	Evaluate students' experiences with a three-dimensional virtual hospital unit.	Descriptive	VI-MED, a virtual hospital unit developed by the School of engineering and School of Nursing at a Midwestern	10 nursing students in the Midwestern US	Faculty-developed 10-item survey with a Likert type scale of 1 (very much) to 5 (not at all). Comments at the end of the survey.	1 VS	The two items with the best scores indicated the game supplied enough assessment data to successfully care for the patients (1.2) and based on your nursing background, were the interventions obvious (1.2). The lowest score was to the question, "were the navigation keys easy to use?" (3.1). Comments ranged from	**6**

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			state-funded university				suggestions to enhance the game to enthusiasm for gaming as a learning tool. "I thought the game was great, really liked the concept behind it" (p. 270).	
Poikela, Ruokamo, & Teras (2015)	Examine how two different teaching methods presented students' meaningful learning in a simulated nursing experience.	Qualitative videography Group 1 – teacher led lecture Group 2 – computer based simulation program	Computer-based simulation	40 first-year nursing students in two universities in northern Finland	Questionnaires and videorecordings	6 hours of simulation using a terrestrial trunked radio (TETRA) phone	Students who used a computer-based simulation program were more likely to report meaningful learning themes than those who were exposed to lecture method. Students in Group 1 did not support each other and tried to solve the problem by themselves. Students in Group 2 were very eager to try the TETRA phone in practice and were participative. Students who learned through the computer-based simulation were much more willing to use the phones.	**6**
Schaffer, Tiffany, Kantack, & Anderson (2016)	Describe the educational innovation of integrating Second Life virtual learning experiences into clinical learning for traditional baccalaureate		Second Life®	48 senior-level baccalaureate nursing students in a public health nursing course in the Midwestern US	Survey with 1 to 4 Likert-type scale, Focus Group	Two of three Second Life scenarios	For development of public health nursing knowledge (the mean was highest for assessing the impact of environmental factors (mean = 2.98) and prioritizing nursing interventions (mean = 2.98). Three themes emerged from the qualitative data: benefits of Second Life, strategies to promote learning, and challenges encountered in	**6**

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	senior students in a public health nursing course.						completing Second Life scenarios. Benefits included an increases awareness of the public health nursing role and exposure to situations they might not experience in clinical practicum. Challenges included technology issues and wanting a greater level of interactivity. Some scenarios were not realistic enough.	
Schmidt & Stewart (2010)	Evaluate a Second Life public health office in an online accelerated nursing program.	Descriptive, quantitative	Second Life®	28 accelerated nursing students in the Midwest US	Surveys on a scale of 1=strongly disagree to 4 = strongly agree).	Various exercises in SL	When asked to rate the helpfulness of the disaster triage scenario to their learning, the mean was 3.14. The mean score of 2.74 reported for the clinical live chats suggested the activity was less helpful. When asked what they liked best, students commented they enjoyed the ability to interact with others and work in groups. They enjoyed real-life scenarios.	**6**
Seefeldt, et al. (2012)	Evaluate the effectiveness of Second Life in interprofessional case discussions for health professions students	Pre-posttest design	Second Life®	47 students from pharmacy, nursing, physician assistant, physical therapy, and occupational therapy in the Midwest US	Researcher-designed surveys	1- hour long discussions of a mock patient case	Students had favorable impressions of the activity with 60% agreeing or strongly agreeing that Second Life was an effective method of conducting interprofessional education. Students cited convenience (47%), flexibility, ability to discuss the case in real-time with other students, and the	**6**

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							interactive nature of the sessions as advantages. Technical issues (43%) were the most commonly reported challenges. 15% commented on the lack of nonverbal communication as a negative aspect.	
Shuster, Giddens, & Roehrig, (2011)	Explore the student experience of *The Neighborhood*	Qualitative descriptive	*The Neighborhood* virtual community	40 undergraduate students enrolled in a baccalaureate nursing program in the southwest US	A 4 question survey using open-ended questions about *The Neighborhood*	Use of *The Neighborhood* in one or more courses	Analysis revealed themes of 1) Emotional Connection, and 2) Integration between *The Neighborhood* and Class Work. "I like the realness of *The Neighborhood"*. "Much more interesting than reading a textbook." (p. 224). Student concerns including negative comments were noted. The most common concern was "too many characters" "too many families" (p. 224). The second greatest concerns was the amount of time required to keep up with the characters and events.	**6**
Smith & Hamilton (2015)	Evaluate the effectiveness of VR simulation as a teaching strategy for preparation of students for successful performance and validation	Quasi-experimental, Convenience sample	Foley Catheter Simulation using Autodesk Maya deploying the Unity game engine developed	20 associate degree in nursing students enrolled in Fundamentals of Nursing in the Southeastern US	Logs of practice time, Skills evaluation tool, Visual Analog Perceived Preparedness Scale	Access to a VR simulation program to practice catheterization skills	There were no statistically significant differences between the experimental and control groups.	**3**

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	of Foley catheter insertion		by a graphic designer, simulation modeling developer, and engineer					
Strang Zook, Hulton, Dudding, Steward & Graham (2018)	Examine the impact of a curriculum including virtual stimulation on students' attitudes and values toward interprofessional collaborative practice.	Quasi-experimental	SecondLife	26 university students (30.8% nursing, speech-language pathology 34.6%, and graduate psychology 34.6%) in the US	Interprofessional Socialization and Valuing Scale (ISVS) (a 24-item self-report tool)	4 virtual simulations	Students demonstrated improvements in scores in all 3 subscales over the 4 data collection points (p<0.01).	**3**
Strekalova, Krieger, Kleinheksel& Kotranza, (2017)	Examine the communication strategies used by undergraduate nursing students to express empathy during simulated health history interviews	Retrospective descriptive	Health history simulation with a virtual patient from Shadow Health	343 undergraduate nursing students in US	Transcripts of previous conversations between undergraduate nursing students and a virtual patient	none	Of 3087 potential disclosures (9 for each of the 343 students), students encountered 1625; of the disclosures encountered, they provided empathic responses to 33.54% (n = 545) of disclosures. On average, nursing students encountered 4.7 disclosures and provided empathic support to 1.6 disclosures per exam. Sophistication of language to express empathy varied depending on the disclosure	**6**

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							topic. These findings suggest that empathy as a learned skill can be incorporated into a variety of nursing contexts.	
Sweigart, Hodson-Carlton, Campbell, & Lutz, (2010)	Evaluate the use of SL to teach nursing students interviewing skills.	Descriptive mixed methods	Second Life®	201 nursing students in the US	Faculty-developed evaluation tool using a Likert type scale from 1 (strongly disagree) to 5 (strongly agree), interview transcripts	1 health history interview in SL	60% of the pilot cohort agreed or strongly agreed SL was conductive to a good interview. The percentage increased to 89% when the interview was prior to face-to-face interview. 82% of students agreed or strongly agreed that the client's answered seemed believable. Students indicated "very helpful" and "SL will allow us to practice many things that we will use in our nursing careers" (p. 14). Less than 5% of the 201 students responded negatively (to "they were better prepared to take a nutritional assessment" or "would be interested in completing other interviews in SL") p. 13.	**6**
Sweigart & Hodson-Carlton (2013)	Compare quality of student interviews by students with and without the virtual environment urogenital-sexual	Quasi-experimental	Second Life®	Nursing students in the Midwestern US	124 taped interviews by students without the virtual experience and 123 taped interviews with students who had the	A virtual environment urogenital-sexual interview	Students with previous avatar experience demonstrated a significant difference in number of questions asked (t_{245} = -4.267, p<.001) and showed a significant difference in the number of follow-up questions asked ($t_{223.535}$= -2.576, p=.011). Students who participated in	**3**

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	interview experience				virtual experience	experience	focused assessments with client avatars in the virtual environment demonstrated a significantly more thorough subsequent health history interviews with community volunteer clients. Students perceived the avatar clients were realistic and better prepared them to conduct an interview in the clinical setting.	
Sweigart, et al., (2016)	To test the utility and acceptability of virtual learning environment immersive training using the TeamSTEPPS curriculum, and to examine the change in teamwork attitudes regarding interprofessional communication.	Pre-posttest design	A virtual simulation of a hospital environment using the platform of Unity 3D designed by digital intermedia designers at Ball State University	109 professional students from nursing (n=45), medicine (n=13), occupational therapy (n=27), and social work (n=7) in the US.	The TeamSTEPPS Teamwork Attitudes Questionnaire (T-TAQ)	3, 5-minute simulations	Participants showed significant attitude changes in the categories of leadership, situation monitoring, mutual support, and communication ($p < .05$), with significance in four of the six indicator attitudes in the communication section at the ($p < .001$) level. The domain of Team Structure was not impacted at a statistically significant level.	**3**
Sunnqvist, Karlsson,	Investigate 4th term nursing students'	Descriptive, convenience	Web-based Simulation of Patients	23 4th term (of 6 terms) pre-registration	surveys	5 virtual	Categories emerged of: Interactive computer system, Activity produced knowledge;	**6**

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Lindell, Fors (2016)	opinions on the use of virtual patients for assessment in a mental health and ill-health course module.		System (Web-SP)	nursing students in Sweden		patient cases	High potential for development in psychiatric care. On a scale of 1-10, students were positive to the use of virtual patients in psychiatry (median 7) and to use virtual patients in their continued nursing education (median 8). Virtual patients have a good potential for training students to meet psychiatric patients.	
Tait, Tait, Thornton, & Edwards (2008)	Evaluate a critical care e-learning scenario for student nurses	Descriptive quantitative	eWARD project, developed by Swansea University	144 third-year nursing students in the United Kingdom	Questionnaire with 20 statements using a five-point Likert scale	e-learning scenario	93.8-100% of students agreed or strongly agreed with the statements about ease of use. 99.3-100% of students agreed or strongly agreed with the statements about interactivity of the content. When asked about realism of the scenario, 77.8% to 95.8% agreed or strongly agreed. On scores about confidence, 68.8% to 97.9% indicated agree or strongly agree. The overall attitude to the scenario was positive.	**6**
Tiffany & Hoglund (2014)	Examine perceptions and experiences of using Second Life as a teaching/learning strategy.	Descriptive, convenience sample	Second Life®	12 nursing students enrolled in a graduate nursing education course in the US	Faculty-developed surveys	8-10 hours per week of VS for 4 weeks	Student challenges emerged including difficulties moving the avatars. Students felt the interactions between avatars reflected real life. Students noted presence and connectedness, benefits, and barriers and challenges. All students felt the learning	**6**

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							experience could have been improved if they had spent more time with a faculty mentor in Second Life. 7 students reported that they would pursue use of the virtual worlds in teaching/learning strategies in their future nurse-educator role.	
Tiffany & Hoglund (2016)	Explore how Second Life facilitated student exploration of concepts of cultural awareness, inclusivity, diversity, bias and –isms related to the practice of nursing.	Qualitative, thematic analysis	Second Life®	15 graduate nurse educator students in the Midwest US	Written assignments	10 hours of VS	The concepts from the course readings emerged in the students' experience of the VS: projective identity, recognizing bias, and micro-aggression. Ten of 15 students expressed they expected to be treated with hostility and/or avoidance because of their avatar. One student indicated, "to be able to be inclusive, one has to really try to see and experience what a minority sees. It is impossible to do this if one is not a minority, but taking the time to truly reflect on how one is treated when pretending to be a minority could give some perspective" (p. 121).	**6**
Tjoflat, BrandeggenStrandberg, Dyrstad,	The aim of the study was to evaluate second year	Descriptive and a convergent mixed method design	vSim® for Nursing	Sixty-five second year nursing students with a mean age	Developed by authors. 7-item questionnaire	two hourly VS	The majority of the nursing students (40% strongly agree, 23% agree) reported that working with vSim® for	**6**

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Husebo, & (2018)	Norwegian nursing students' experiences with the virtual clinical simulation scenario in surgical nursing from vSim® for Nursing.			of 24 years (19–49 years) in Norway	with response options on a 5-point Likert scale (1 representing strongly agree and 5 representing completely disagree). Plus five open-ended questions		Nursing was motivating, promoted learning (31% strongly agree, 35% agree) and was useful for gaining new knowledge (39% strongly agree, 34% agree) as well as for reinforcing knowledge about surgical nursing care (51% strongly agree, 29% agree) (Table 2). The students stated that working with the virtual simulation was a good preparation for their clinical placement studies in surgical wards (46% strongly agree, 25% agree) and that the content of the virtual simulation was directly relevant to their role as a nurse (48% strongly agree, 35% agree). Although some students (n = 21) reported difficulties in navigating in vSim®, the majority of them (14% strongly agree, 43% agree) reported that the product was easy to use. The majority of the students (79%) recommended the virtual simulation for future use.; The results also showed that students found that the virtual simulation was not so easy to navigate and did	

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							not contribute, reinforce or promote learning. Almost one third of the students (28% slightly disagree, 4% completely disagree) stated that the product was challenging to use.; Twenty percent of the students did not recommend the virtual simulation vSim® for Nursing for future use.	
Tilton, Tiffany, Hoglund (2015)	Describe a non-acute-care virtual clinical simulation experience used in a clinical course focused on adults with chronic health conditions	Mixed-methods, convenience	Second Life®	61 junior-level nursing students in the US	Learner HPS Evaluation© survey with two open-ended questions	4 encounters	Mean scores for clinical ability items ranged from 2.46-5.22 (on a scale of up to 6.0). Mean scores for items on perceptions of the learning environment ranged from 3.1 to 5. Students with a more experienced faculty member rated survey items higher. Students favored the encounter with the facilitator assuming the avatar's persona and voice and students appreciated the relaxed learning environment of the virtual simulation experience.	**6**
Tschannen, Aebersold, McLaugh-lin, Bowen, &	The purpose of this study was to explore the use of virtual simulations to improve knowledge transfer of	quasi-experimental design	virtual nursing unit in Second Life	115 nursing students in university in their final year of a four-year baccalaureate	Modified Capacity to Rescue Instrument (CRI) 17 item	three virtual simulations in addition to classroom	Total CRI score for the intervention group (m=21.98, SD 4.29) was significantly higher than the score for the control group (m=20.09, SD 4.05).	**3**

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Fairchild (2012)	nursing students in one Midwest University			nursing program in the US		content learned by control group		
Tschannen, Dorn, & Tedesco (2018)	To examine virtual training on Crew Resource Management (CRM) principles of effective leadership and followership on participants' knowledge, applicability, and intended behaviors.	quasi-experimental design	Second Life	53 graduate students (18 pharmacy, 15 medicine, 6 nursing and 2 social work) in US	10-item pre/post knowledge test measuring understanding of effective leadership and followership principles; 11-item survey of applicability of the training and intended behaviors	self-learning module and an optional virtual simulation compriseed of 3 scenarios	Knowledge improved significantly post-training ($t(40)=10.47$, $p<0.001$). Pharmacy students scored significantly lower on the post-knowledge test than medicine and nursing students [$F(2,36)=5.99$, $p=0.006$]. Participants completing the module reported learning new skills and knowledge ($M=4.17$, $SD=0.54$) and intended to use skills/knowledge gained from the training in clinical practice ($M=4.29$, $SD=0.56$). Those completing the simulation exercise ($n=10$) found value in the experience, again noting strong application to practice ($M=4.9$, $SD=0.32$) and intended use in practice ($M=4.9$, $SD=0.32$).	**3**
Ulrich, Farra, Smith, Hodgson (2014)	Explore the experience of students participating in a virtual reality simulation	Mixed-methods exploratory, descriptive design (although quantitative results are	Microsoft Kinect ™	107 senior baccalaureate nursing students at 2 universities in the Midwest of the US	Structured interview guide with 10 questions developed by the researchers.	5-10 minutes VRS	Three themes emerged: The experience of VRS, The learning process, and The implementation of the learning activity. Students felt engaged, safe, embeddedness, ability to recall information,	**6**

Table 1. Summary Table of Research Studies in Virtual Simulation

	(VRS) for the disaster competency of decontamination.	reported in a separate article)			Focus group sessions		sequencing, embodiment, extension, student preparation, technical concerns, missing content, rehearsal and/or practice time. Students indicated that VRS was positive, fun, and safe.	
Verkuyl, Atack, et al., (2018)	To examine three debriefing methods after a virtual simulation: in person, virtual, and self.	RCT	Virtual Gaming Simulation	200 undergraduate nursing students in Canada	Knowledge test -10 items; Self-Efficacy Survey; Debriefing Experience Scale (20-items)	30-60 minute virtual simulation	All groups made significant knowledge and self-efficacy gains. All groups rated their experience highly. There were no significant differences in outcomes between groups providing evidence to support alternative debriefing methods beyond the traditional in-person approach.	**2**
Verkuyl, Lapum, et al., (2018)	To explore self-debriefing, virtual debriefing, and in-person debriefing after a virtual gaming simulation	Qualitative	Virtual Gaming Simulation	24 nursing students in Canada	Focus groups	Virtual gaming simulation of home visits	Four thematic areas emerged including defusing, discovering, deepening, and environment.	**6**
Verkuyl, Romaniuk, Mastrilli, et al. (2018)	To assess usability of a virtual gaming simulation	Descriptive	Virtual Gaming Simulation	Six nursing students and six nursing faculty members in Canada	Interviews and surveys	Virtual gaming simulation of home visits	Participants found the VGS engaging, realistic, and similar to a clinical experience.	**6**

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Verkuyl, Hughes, Tsui, Betts, St-Amant, & Lapum (2017)	Explore students' experiences of the virtual gaming simulation (VGS) of a community home visit specific to its effects on their knowledge, confidence, and satisfaction.	Descriptive, convenience	VGS was developed by a team of faculty and instructional designers consisting of film-clips. Users collect assessment data, make interventions, and experience consequences of choices.	20 first year nursing students in Canada	Focus groups	30-60 minute VGS	Five themes emerged: Experiential learning, The learning process, Personal versus professional, Self-Efficacy, and Knowledge. Positive outcomes including satisfaction, high levels of engagement, enhanced knowledge, and self-efficacy were noted.	**6**
Verkuyl, Romaniuk, Atack, Mastrilli (2017)	Compare a virtual gaming simulation (VGS) with the traditional laboratory simulation in respect to: students' pediatric nursing care knowledge, self-efficacy, and satisfaction.	RCT	VGS was developed by a team of faculty and instructional designers with video-clips of standardized patients activing as a child and mother in a hospital setting.	47 students who had completed second year in a baccalaureate nursing program or practical nurse bridging program in Canada	Pediatric Skills Self Efficacy Survey Pediatric nursing care knowledge test (10 multiple choice items) Adapted Simulation Satisfaction Survey	60-90 minute VGS	Pediatric Nursing Care Knowledge: Only the VGS group demonstrated statistically significant learning on the posttest (t=-2.12, df=22, p = 0.045). Pediatric skill self-efficacy: the VGS group made statistically significant greater gains (t=-2.1, df = 22, p = .045) Both groups were satisfied with the simulations demonstrating no differences for the two groups.	**2**

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Weideman, Young, Lockhart, Grund, Fridline, & Panas (2016)	Evaluate a virtual simulation experience (VSE) facilitating student access to diverse cultures and strengthening their ability to provide culturally congruent care	Pre-posttest design	Virtual Simulation Experience (VSE) developed by the investigators including videotaped vignettes using modules in Blackboard ™	136 nursing students in the US	Jeffreys' Transcultural Self-Efficacy Test (TSET). Care plan rubric (developed by investigators with a top score of 50 points). Post-course evaluations of the VSE on a student survey from 1-5.	Two modules of VSE over 2 weeks	Students' perceived clinical cultural competence significantly increased as measured by the TSET (t=10.06, p < .001). Mean scores for the Amish care plan were 45.65 (SD = 2.029) and 45.53 (SD = 2154) for the African American care plan. The project team, community members, and students viewed the VSE as a valuable experience. Cultural competence can be strengthened through VSE.	**3**
Wright, Tinnon, Newton (2018)	Evaluate the effectiveness and participant satisfaction of vSim for Nursing in an Adult Health Nursing course	Quasi-experimental, two-site	vSim for Nursing	103 undergraduate nursing students in the US	8-item questionnaire created by faculty, 10-question post-simulation quiz	2 virtual simulations	There were no significant differences in exam scores between the simulation groups and non-simulation group. 91% of participants indicated that VS helped them understand adult health concept and found it beneficial to learning.	**3**