

Number	Author, Year, Country	Study Design	Study Population	Aim of Study	Interventions	Outcome Measures	Results
1	Ertmer et al (2010) USA	Cross-case comparison design	164 Nursing students	To examine how undergraduate nursing students demonstrate critical thinking during high fidelity simulations and debriefing sessions, and particularly to investigate how critical thinking varied across different roles.	Student divided into small groups (2-3) to role-play a medical emergency (stroke) within a high fidelity simulation environment.	Interviews (n=14) and collaborative debriefings (n=6)	Although students in all three roles displayed instances of reflection, contextual perspective, and logical reasoning, these were not distributed evenly across roles, with family members demonstrating fewer instances of reflection and logical reasoning and secondary nurses demonstrating fewer instances of contextual perspective.
2	Hyunsook et al. (2015) Korea	Multi-site, pre-test, post-test design.	237 nursing students	To evaluate the effect of an integrated pediatric nursing simulation used in a pediatric nursing practicum on students' CT and to identify the effects of differing numbers of simulation exposures, or "dosing" levels, on CT in a multi-site	Students at school A completed one simulation session, whereas students at schools B and C completed two and three simulation sessions, respectively. Yoon's Critical Thinking Disposition tool (2008) was used to measure students' CT abilities	Critical thinking and simulation effectiveness	With a single exposure, there were no statistically significant gains in CT, whereas three exposures to the courseware produced significant gains in CT.
3	Abuzaid & Elshami (2016) United Arab Emirates	Evaluation study	Radiology professionals	To evaluate the value of scenario-based simulations in radiology education and their impact on professional learning outcomes	Scenarios were presented online to radiology professionals for 6 months.	At the end of the study, the scenarios were evaluated regarding design, content, and their role in improving critical thinking	Each participant completed an average of 13 scenarios with an approximate time of 23 minutes for each. The majority of participants agreed or strongly agreed that the scenarios were well designed (94%), were appropriate to their level of knowledge (70%), and helped them in critical thinking and in understanding similar cases (79%)
4	Munroe et al. (2016) Australia	Pre-Post design	38 Emergency Nurses	To evaluate the effect of the new evidence-informed nursing assessment framework HIRAID on the quality of patient assessment and fundamental non-technical skills including communication, decision making, task management and situational awareness	Video recordings of participants performance in immersive simulations of common presentations to the emergency department were evaluated, as well as participants documentation during simulations.	Nontechnical skills, including decision making, were all enhanced when applying the HIRAID approach to patient assessment.	From pre- to post-intervention participants performances mean critical thinking scores increased.
5	Padden-Denmead et al (2016) USA	A descriptive correlational design	23 baccalaureate nursing student	To investigate the use of the combination of clinical simulation with debriefing and guided reflective journaling to simulate CT	Guide for Reflection (GFR) was used as a format for the debriefing and reflective journal entries	Critical thinking in simulation	A statistically significant positive relationship ($p < .01$) was found between mean HCTSR and LORAA scores on all three journal entries, but no relationship to CT during simulation or on standardized test scores. The results also indicated support for use of the guided reflection after significant learning experiences.
6	Hageman et al (2017) Germany	Randomized, double-blinded study with a pretest-posttest design	104 4th-year medical students	To evaluate the effects of a tailor-made, non-technical skills seminar on medical students' behaviour, attitudes, and performance during simulated patient treatment	Students randomized to either non-technical skills seminar or a medical seminar. Human patient simulation was used as an evaluation tool. Students performed the same simulated emergency scenario before the seminars to provide baseline measurements. After seminar students got a second scenario and behavioral markers for evaluating their non-technical skills were rated	Non-technical skills concerning situation awareness	Non-technical skills concerning situational awareness and teamwork improved from simulation 1 to 2 in the NTS group. Decision making improved in both groups. Perceived stress decreased from simulation 1 to 2 in both groups. Medical endpoints and patients' outcomes did not differ significantly between the groups in simulation 2
7	Macauley et al. (2016) USA	Systematic review	31 Articles met the inclusion criteria	The purposes of this systematic review were to systematically review the literature to determine whether simulated experiences impact the development of CDM, CR, or CT in students in health professions educational programs, to assess the quality of evidence for the effectiveness of simulation in developing CDM, CR, or CT in health professions students.	Review of the literature	7/31 articles measured critical thinking. 5/31 found increased Critical thinking after simulation and 2/31 found no significant difference	The results demonstrate that simulation improves CDM, CT, or CR. The outcomes from the studies revealed that more repetitions in a simulated environment produced greater changes.
8	Kim (2018) South Korea	quasi-experimental design	76 Nursing students	To investigate the effects of simulation education on nursing students' self-efficacy and critical thinking skills in emergency cardiac arrest situations.	Group A completed a roleplay of an emergency cardiac arrest situation in a clinical setting, while Group B first listened to a lecture on the procedure. There after they were enrolled in a simulation experience	Group B showed a significant increase between pretest and posttest, while Group A showed no significant difference	Conducting the simulation exercise after the roleplay was a more effective teaching method than conducting it after the lecture
9	Mai et al. (2018) USA	Retrospective qualitative analysis	A total of 79 students over 4 academic years evaluated the experience (Nursing and Physical students)	To foster interprofessional collaboration and critical thinking in a mock critical care setting	Students were exposed to HFS (2 cases).	Nursing students review the medical diagnosis, lab values, medications, and SBAR (situation, background, assessment, recommendation) communication technique	HFS is a valuable tool to incorporate into curriculum to assess learning outcomes that are expected of health care professionals. Interprofessional collaboration could lead to stronger patient-centered care given the sharing of knowledge that occurs across disciplines.
10	Unver et al (2018) Asia	one-group pre-test post-test model quasi-experimental study	one-group pre-test post-test model quasi-experimental study	To analyze the effects of a hybrid simulation technique used with nursing students in a scenario about the emergency setting	Hybrid simulation case	critical thinking, decision-making skills, and self-confidence	early all participants reported that the simulation improved their critical thinking, decision-making skills, and self-confidence before the clinical activity and that they felt as though they were real nurses during the activity (94.7%, 97.3%, 84.2%, and 92.1%, respectively).
11	Chang et al (2019) Asia	quasi-experimental design	72 4th-year nursing students from two classes of a nursing school	investigated a novel pedagogy for nursing school students' ECG learning performance using a contextual game	A 2 week experiment was conducted to compare the learning performances of the nursing students who played the ECG contextual game and those who learned with traditional instruction.	pre- and post-knowledge of the ECG course	The experimental results show that the students learning with the contextual game showed better learning performance, attitude, motivation, and critical thinking tendency than those who received the traditional instruction

12	Odreman & Clyens (2020) Canada	Debriefing Experience Scale (DES)	34 nursing students	How the use of concept mapping during debriefing related to an increase in active learning by analyzing thoughts and making connections to clinical concepts.	After a 20-minute video showing the clinical interaction between nurses and a patient, 34 nursing students debriefed their observations in either a traditional team debriefing session or in a debriefing session using concept mapping.	students debriefed their observations in either a traditional team debriefing session or in a debriefing session using concept mapping	increase in analysis of thoughts, feelings, and critical thinking and connections to clinical concepts for students who used concept mapping during the debriefing session
13	Peddle (2019) Australia	descriptive exploratory approach	376 undergraduate, university or clinical professions	to investigate participant perceptions and the learning experiences when engaging in virtual simulations focused on developing non-technical skills.	online voluntary survey collected qualitative extended responses from participants after each virtual simulation	communication, teamwork, decision making, critical thinking and problem solving, and, to a lesser extent, situational awareness	gaging in virtual simulation can develop awareness of non-technical skills, as well as confidence and vigilance in practice and mindfulness of a person-centred approach to healthcare.
14	Al Ghanbi & Arulappan (2020) Saudi Arabia	An integrative review	11 Articles met the inclusion criteria	the outcome of repeated simulation experience on self-confidence, critical thinking, knowledge, competence, and satisfaction of nurses and nursing students.	Review of the literature	2 Articles were on the effect of simulation on critical thinking. The researchers concluded that HFS can heighten CT.	Repetitive simulation experience is valued by the nurse educators as a valuable teaching methodology to reinforce the student's learning outcomes.
15	Luu <i>et al</i> (2020) USA	cross-sectional validation study	six groups of subjects: pre-medical undergraduate students, 2nd year medical students, pediatric residents, general pediatrics attending physicians, pediatric emergency medicine	to generate validity evidence for a serious game in assessing multi-patient care skills among a variety of learners.	digital serious game VitalSigns™ simulating multi-patient care within a pediatric ED. Subjects completed 5 virtual "shifts," triaging, stabilizing, and discharging or admitting patients within a fixed time period; patients arrived at cascading intervals with pre-programmed deterioration if neglected	diagnostic accuracy (i.e. critical orders, diagnoses), efficiency (i.e. number of patients, time-to-order) and critical thinking (number of differential diagnoses);	A digital serious game depicting a busy virtual ED can distinguish between expected experts in multi-patient care at the pre- vs. postresidency level. Further study can focus on whether the game appropriately assesses skill acquisition during residency
16	Radaba & Masha'al (2020) Asia	equivalent control group pretest-posttest experimental study	102 Undergrad Nursing students	to examine the effectiveness of branching path simulation in promoting the critical thinking skills of undergraduate nursing students.	students were randomly assigned and divided into two equal intervention and control groups and each group attended different training sessions. The control group was trained by traditional lectures while the intervention group was trained by branching path simulation. The researcher used a demographic questionnaire and the Critical Thinking Self-Assessment Scale (CTSAS) for data collection.	After the training sessions, the mean scores of the CTSAS and its subscales domain in the intervention group were significantly higher than the control group.	Branching path simulation is an effective teaching method to promote students' critical thinking skills. Future studies are recommended to examine the effect of branching path simulation on other nursing students learning outcomes.
17	Arunachalam <i>et al</i> (2021) Malaysia	Quantitative Survey	93 oral health students	To evaluate virtual role-playing simulation as clinic: A model for experiential learning of critical thinking skills	testing almost all of these core attributes in a real-time virtual role-playing simulation activity	3 key aspects using a 5-point scale: (1) information gained, (2) relevance and appropriateness of the topic, and (3) overall learning experience	Participants experienced a format of virtual teaching and learning that elevated the skill acquisition in higher-order cognitive functions, especially clinical reasoning and critical thinking
18	Barlett <i>et al</i> (2021) USA	Controlled trial	Oral graduate students from two cohorts who were enrolled in a swallowing disorders course in consecutive academic years (n=50)	to determine if using a human patient simulator (HPS) to train speech-language pathology graduate students in CSE improved knowledge, preparedness, and anxiety as compared to traditional instruction alone	Students in the experimental group participated in a simulation experience in which they performed a CSE on an HPS, generated a treatment plan, and communicated in real time with the HPS, the patient's wife, and a nurse	short- and long-term CSE knowledge, and written feedback from instructors and students	Students who participated in simulation training had significantly higher long-term quiz accuracy than the control group, but their short-term quiz scores did not differ
19	Ling <i>et al</i> (2021) Malaysia	multicenter, experimental, pretest-posttest double-arm intervention study	final-year undergraduate nursing students (N = 407)	To compare learning outcomes (knowledge and critical thinking skills) among undergraduate nursing students in Malaysia.	An adult code blue drill simulated program using HFPS versus LFPM	30-single best answer questions and the California Critical Thinking Disposition Inventory	Simulation-based education using HFPS is advantageous over LFPM in increasing knowledge and critical thinking skills in code blue management among nursing students
20	Louw (2021) SA	qualitative descriptive design	10 Radiography students	To report on the application of cognitive load theory (CLT) and students' responses in terms of problem solving and new insights during and after a simulation experience	Eighty students participated in presimulation knowledge, skills and attitudes acquisition and 10 participated in the simulation.	comprehensive summarisation of students' problem-solving abilities and emerging new insights	After application of CLT, critical thinking to facilitate problem solving during simulation was suggested and post-simulation reflection facilitated new insights