Table 3. Characteristics of included reviews (N = 15).

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| --- | --- | --- | --- | --- | --- |
| **Authors (Year)****Type of participants** | **Aim/objectives** | **Review type/number of studies (n)****N of databases sourced (Date range of database searching)** | **Instrument used to appraise the primary studies** | **Method of synthesis/analysis employed to synthesize****the evidence**  | **Relevant key findings** |
| Alhonkoski et al. (2021)Mixed health care students | To describe the way in which 3D technology has been used in health care education for teaching and learning and the educational outcomes related to 3D technology | Scoping review (n = 31)7 (Not reported) | * N/A
 | * Narrative description and thematic analysis
 | * Learning with 3D technology generated the outcomes in user experience (satisfaction), motivation (motivation to learn), attitudes (self-confidence to learn), and emotion (feedback, presence experienced, feeling of interactivity, and emotional feelings).
* The correlation between 3D technology and positive learning outcomes is debatable, but 3D technology can be a useful tool for student engagement.
 |
| Chen et al. (2020)Mixed nursing students | To determine the effectiveness of VR for nursing students in five areas: confidence, knowledge, performance time, skills, and satisfaction | Systematic review with meta-analysis(n = 12)5 (Inception through December 2019) | * Cochrane Risk of Bias
 | * Meta-analysis conducted using RevMan 5.3
 | * VR education was more effective than traditional or other simulation methods for the outcome of knowledge.
* There were no significant differences between VR education and other methods for the outcome of skills, learners’ satisfaction, confidence, and performance time.
 |
| Choi et al. (2021) | To review the effectiveness and barriers of VR | Systematic review (n = 9)6 (January 2010 - March 2021) | * The Medical Education Research Study Quality Instrument (MERSQI)
 | * Grouped by outcome but unable to complete a meta-analysis due to variety of outcome tools
 | * Participants showed improvement in learning performance and cognition as well as psychomotor clinical skills.
* The usability assessment resulted in participants’ positive responses.
 |
| Coyne et al. (2021)Mixed nursing and medical students | To review the use of VS to evaluate clinical competence | Integrative review (n = 23)4 (2008 - 2020) | * Mixed Methods Appraisal Tool (MMAT)
 | * Qualitative thematic analysis, but unclear for quantitative date
 | * The results of the review indicated the VS increased student confidence, knowledge, and performance relevant to the skills taught.
* Four themes were identified: (1) pedagogy differences across disciplines, (2) debriefing strategy to enhance learning, (3) preparing health care professionals in a safe and cost-effective environment, and (4) managing challenges of VS.
 |
| De Gagne et al. (2013) Mixed health care students and nursing faculty | To review the status of current evidence on VR use in nursing education and other health professions | Integrative review (n = 12)7 (January 2000 - March 2012) | * N/A/NR
 | * Thematic analysis
 | * Second Life® was the most frequently used platform in the reviewed studies.
* Three themes emerged: (1) clinical reasoning skills-VR increases knowledge and confidence; (2) VR can provide student-centered learning opportunities; and (3) instructional design considerations are a factor in VR utilization.
 |
| Fealy et al. (2019) Mixed health care students and midwifery nurses | To identify the use of iVR in maternal health/midwifery and review how iVR is integrated | Scoping review (n= 2)10 (Not reported) | * Hawker tool
 | * Only two studies, and these were not synthesized but summarized
 | * There was limited literature on the topic of iVR in tertiary nursing and midwifery education.
* iVR offers potential benefits over face-to-face learning in terms of student engagement and fun.
* There was no improvement in skill retention over time with iVR.
 |
| Foronda et al. (2020) Mixed health care students | To review the impact of VS on learning in nursing students | Systematic review (n = 80)4 (1996 - 2018) | * Critical Appraisal Skills Programme (CASP)
 | * Data was grouped by frequency of learning outcomes using the extraction table
 | * VS improved learning outcomes including knowledge, satisfaction, and skills.
* Critical thinking and self-confidence results were mixed.
* No significant differences were found in knowledge retention over time between VS and traditional teaching methods.
 |
| Irwin et al. (2015) Not reported | To better understand how Second Life® is being used in nursing education | Systematic review (n = 14)7 (2008 - 2014) | * Tool NR
 | * Thematic analysis
 | * Of the 14 studies reviewed, 10 used participant responses via open questioning.
* Three themes were identified: (1) transferability-participants could link theory to the virtual world, (2) learner-centered approach using Second Life®-increased student engagement and participation, and (3) evaluation of Second Life® as a new and emerging education technology- investigators either used a valid instrument or created their own tool.
 |
| Jallad & Işık (2021) Mixed nursing students | To evaluate the educational effectiveness of VRS on skills, performance, satisfaction, self-confidence, and anxiety | Systematic review (n = 23)7 (January 2009 – December 2019) | * Cochrane Handbook for Systematic Reviews
 | * Narrative synthesis based on outcomes
 | * Studies showed improvement in cognition, overall satisfaction, and skills with VRS.
* Participants reported increased self-confidence, self-efficacy, and reduced anxiety.
 |
| Kim et al. (2021)Mixed health care students  | To understand research trends of MR in nursing education worldwide | Scoping review (n = 10)6 (1990 - April 2021) | * Hawker tool
 | * NR
 | * Unity engine was most frequently used to develop MR, and the most common visual device was Microsoft HoloLens.
* Knowledge, clinical performance, satisfaction, critical thinking, and confidence were evaluated during VS with knowledge being the most common.
 |
| Plotzky et al. (2021) Mixed health care students and staff | To map the existing literature on VR in nursing education | Systematic mapping review (n = 22)8 (Not reported) | * Educational Intervention Critical Appraisal tool
 | * Narrative synthesis
 | * Educational objectives of VR simulation included procedural skills training for technical knowledge and proficiency, emergency response training focusing on confidence, soft skills training, and psychomotor skills.
* Complex skills, such as auscultation and empathy by mimicking the life of dementia, were experienced.
 |
| Rourke (2020) Prelicensure nursing students | To answer how VR simulation compared to simulated practice in the acquisition of clinical psychomotor skills  | Systematic review (n = 9)5 (Not reported) | * Modified Guideline from The Centre for Reviews and Dissemination
 | * Narrative synthesis
 | * Compared to traditional methods, VR increased knowledge and performance of skills.
* There were mixed results for the time required for skill completion and skills success.
 |
| Shin et al. (2019)Mixed nursing students and registered nurses  | To identify the educational characteristics of VR | Integrative review (n = 40)3 (January 2011 - December 2016) | * Mixed Methods Appraisal Tool

(MMAT)  | * Content analysis and conceptual clustering
 | * The authors identified the following general simulation characteristics: debriefing method, feedback, teaching method, theoretic framework, scenario outcome, and simulation purpose.
* Seven virtual-specific characteristics were identified: instructor competency, mode of representation, participant role, interaction, type of platform, virtual framework, and virtual ethics.
* To produce effective VS, educators should incorporate characteristics of both traditional or general simulation with VS.
 |
| Shorey & Ng. (2021) Mixed nursing students and registered nurses | To understand how the teaching tools of dVRS and iVRS can be used in nursing | Systematic review (n = 18)6 (Inception until December 2019) | * JBI Critical Appraisal
 | * Narrative synthesis
 | * Compared to traditional methods, VS has increased participant anxiety.
* VS showed mixed results for anxiety, knowledge, and skills.
* Advantages included time, active learning, and cost whereas disadvantages focused on technical concerns and limited realism.
 |
| Woon et al. (2021) Mixed nursing students | To understand the effectiveness of VR on learning outcomes in nursing students and identify essential features of VR | Systematic review with meta-analysis and meta-regression (n = 14)7 (Inception until October 2019) | * Cochrane Collaboration Risk of Bias Tool
 | * Meta-analyses by pooling data of the same outcomes under the random-effects model
 | * Compared to traditional teaching methods, VR significantly improved participant knowledge with small to medium effect.
* VR training is most effective in improving knowledge when presented in multiple short sessions using low to medium immersion based on subanalysis.
* Subanalysis showed increases in procedural knowledge using self-guided sessions.
 |

Note: 3D = three-dimensional, AR = augmented reality, dVRS = desktop virtual reality simulation, iVR = immersive virtual reality, iVRS = immersive reality simulation, MR = mixed reality, VR = virtual reality, VS = virtual simulation, VCS = virtual clinical simulation, VRS = virtual reality simulation, NR = not reported