**Appendices**

**Appendix I:** MMAT Mixed-methods appraisal tool

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| Study designs | Methodological quality criteria |
| Qualitative | 1.1. Are the sources of qualitative data (archives. documents, informants, observations) relevant to address the research question (objective)? |
| 1.2. Is the process for analysing qualitative data relevant to address the research question (objective)? |
| 1.3. Is appropriate consideration given to how findings relate to the context, e.g. the setting, in which the data were collected? |
| 1.4. Is appropriate consideration given to how findings relate to researchers’ influence, e.g. through their interactions with participants? |
| Quantitative randomized controlled (trials) | 2.1. Is there a clear description of the randomization (or an appropriate sequence generation)? |
| 2.2. Is there a clear description of the allocation concealment (or blinding when applicable)? |
| 2.3. Are there complete outcome data (80 % or above)? |
| 2.4. Is there low withdrawal/dropout (below 20 %)? |
| Quantitative non-randomized | 3.1. Are participants (organizations) recruited in a way that minimized selection bias? |
| 3.2. Are measurements appropriate (clear origin, or validity known, or standard instrument; and absence of contamination between groups when appropriate) regarding the exposure/intervention and outcomes? |
| 3.3. In the groups being compared (exposed vs. non-exposed; with intervention vs. without; cases vs. controls), are the participants comparable, or do researchers take into account (control for) the difference between these groups? |
| 3.4. Are there complete outcome data (80 % or above), and, when applicable, an acceptable response rate (60 % or above), or an acceptable follow-up rate (depending on the duration of follow-up)? |
| Quantitative descriptive | 4.1. Is the sampling strategy relevant to address the quantitative research question (quantitative aspect of the mixed-methods question)? |
| 4.2. Is the sample representative of the population understudy? |
| 4.3. Are measurements appropriate (clear origin, or validity known, or standard instrument)? |
| 4.4. Is there an acceptable response rate (60 % or above)? |
| Mixed-methods | 5.1. Is the mixed-methods research design relevant to address the qualitative and quantitative research questions (or objectives), or the qualitative and quantitative aspects of the mixed-methods question (or objective)? |
| 5.2. Is the integration of qualitative and quantitative data (or results\*) relevant to address the research question (or objective)?  |
| 5.3. Is appropriate consideration given to the limitations associated with this integration, e.g. the divergence of qualitative and quantitative data (or results\*) in a triangulation design?Criteria for the qualitative component (1.1 to 1.4), and appropriate criteria for the quantitative component (2.1 to 2.4, or 3.1 to 3.4, or 4.1 to 4.4), must also be applied.  |
| \* These two items are not considered as double-barreled items since in mixed-methods research, (1) there may be research questions (quantitative research) or research objectives (qualitative research), and (2) data may be integrated, and/or qualitative findings and quantitative results can be integrated.  |

**Appendix 2: Characteristics of included studies**

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| **Study** | **Phenomenon of interest/Research aim** | **Context** | **Methodology** | **Methods**  | **Participants/cadres** | **Data analysis** |
| Arzu, A., et al. (2014)Psychometric Properties and Reliability of the Turkish Version of the Technology Attitudes Survey and Nursing Students' Attitudes Toward Technology | The purpose of this study was (1) to evaluate the validity andreliability of the Turkish version of theTechnology Attitude Survey, a tool that can be used to determine the attitudes of senior nursing students towards technology in Turkey(2) toexplore their opinions about the inclusion and efficiency of informatics education(3) their attitudes towards the use of technology | Nursing Departments of five universities in Ankara, Turkey Five universities(Başkent University: 33 students, HacettepeUniversity: 105 students, Gazi University: 60students, Ankara University: 43 students,Gulhane Military Medical Academy: 108students) in Ankara, the capital city of Turkey | Quantitative  | Descriptive and cross-sectional studyData was collected via a questionnaire and the Technology Attitude Survey (TAS) | 238 students completed the questionnaire.All female, age was 22.4 ± 1.4 | Descriptive statistics,parametric and nonparametric tests and exploratory factor analysis were used in data analysisThe appropriateness of the data for the factoranalysis and the valid sample number wereevaluated via the Barlett‘s Test of Sphericity andthe Kaiser-Meyer Olkin (KMO) test, respectively.Varimax was chosen as the factor analysisrotation method. The reliability coefficient wasdetermined via Cronbach’ s alpha. The additivityof the survey was evaluated via Tukey‘s Test of Additivity. |
| Dyer, E., et al. (2018). Using virtual reality in medical education to teach empathy. | The project adopted technology that teaches medical and other health professions students to be empathetic with older adults, through virtual reality (VR) software that allows them to simulate being a patient with age-related diseases, and to familiarize medical students with information resources related to the health of older adults | EnglandThe “Alfred Lab” teaches about macular degenerationand hearing loss from the perspective of a seventy-our-year-old African American man. Other new labs teach about Alzheimer’s disease and end-of-life conversations. UNE was the first institution to license this novel product and has been on the forefront of testing each module as it is developed and implementing use with different student populations. | Quantitative | The project used an application that creates immersive VR experiences for training of the workforce for aging services. Users experience age-related conditions such as macular degeneration and high-frequency hearing loss from the patient’s perspective. Librarians and faculty partnered to integrate the experience into the curriculum, and students go to the library at their convenience to do the VR assignment | First-year implementation involved 178 first-year medical students who had a 10-week window to complete the assignment at the library | Software was downloaded from EL and updated as necessary. Pre- and post-assessments,initially created in Google Forms, were migrated to REDCap for better control and security of data. Faculty and library staff codeveloped assessments unique to each program. EL accommodated ourrequests for program-specific login codes, which were linked to program-specific assessments. Thisenabled easy separation of data by program inREDCap. |
| Feldacker, C., et al. (2017). Experiences and perceptions of online continuing professional development among clinicians in sub-Saharan Africa | To ascertain learning preferences as well as identify key barriers and facilitators to learning, with an emphasis on the online CPD experience | sub- Saharan AfricaParticipating countries included Kenya (43%), Namibia (24%), Nigeria (14%), Zambia (7%), Cameroon (3%), Ethiopia (2%), and Botswana (1%). | Mixed Methods | Online, semi-quantitative, structuredSurveyAn online survey using both close-ended and free response was conducted to HCWs in sub-Saharan Africawho completed the University of Washington (UW) School of Medicine online graduate course, “Clinical Managementof HIV.Invitations tothe online survey were emailed to all students in sub- Saharan Africa who participated in the course from 2012to 2016 and identified as medical or nursing professionals.  | Of those invited, 464 (20%) HCWs completed surveys. The respondents were evenly split by gender. The majority (70%) were between 20 and 40 years of age. The respondents included physicians (33%), nurses (27%), and clinical officers (30%). | Respondent data was subsequently imported and summarized using Stata 14 (College Station, TX. Associations were examined between respondent characteristics (age, years of experience, job title, country) andpreferences on learning modalities and between setting (rural or urban) and answers regarding barriers to online CPD using chi-squared testing. Analyzed covariates that were significant at the p <0.05 level using multivariable logistic regression. The responses to the open-ended request for comments were coded in Microsoft Excel using a simplified grounded theory approach, an iterative approach to generate themes from the qualitative data. |
| George, T. P., et al. (2017). Student Perceptions and Acceptance of Mobile Technology in an Undergraduate Nursing Program. | The purpose of this study was to evaluate the student experience of implementing point-of-care (POC)smartphone applications in a first-semester undergraduate nursing program. | This study was an anonymous survey of pre-licensure first-semester Bachelor of Science (BSN)students at a public, rural, four-year university in the Southeast United States. | Mixed methods | Surveys were administered prior to implementing this innovation and after thestudents utilized the apps in direct patient interactions.Qualitative data were obtained through content analysis of students’ responses to six open-endedsurvey questions | Pre-licensure first-semester Bachelor of Science (BSN)students at a public, rural, four-year university in the Southeast United States.Surveyed subjects were students enrolled in the course in fall 2016 semester, and who participated in learning activities in the laboratory settingand community screenings.A total of 71 surveys were completed, out of 78 possible students, for a response rate of 91%.Respondents were 84.5% female (60/71), 15.5% male (11/71); 81.7% (58/71) White/Caucasian, 16.9%(12/71) Black/African-American, 1% other (1/71); 88.7% (63/71) age 18–25 years old, 8.5% (6/71) age26–35 years old, 1.4% (1/71) age 36–45 years old, and 1.4% (1/71) age 46–55 years old  | Two authors coded the survey questions to identify and determine repetitive themes; agreement was reached on any differences. Qualitative data onthe post-survey was obtained through content analysis of six questions. The researchers coded theopen-ended survey questions to identify and determine the categories and repetitive themes found. Any differences were discussed and consensus was reached on the themes. |
| Heden, L. and L. Ahlstrom (2016). Individual response technology to promote active learning within the caring sciences: An experimental research study | The aim of this study was to evaluate individual response technology as a complement during lectures for students in higher education, in terms of the students' experiences of participation, engagement, and active learning. Also of interest was whether this technology can be considered a supportive technical system | SwedenAt a Swedish metropolitanuniversity | Quantitative  | This study was an intervention study to evaluate active learningwithin the caring sciences. Each participant could be represented more than once (e.g., by participating in both the pediatric and the statistic lecture).Data were collected through a questionnaire where levels of each condition were reported on a numericrating scale (0–10) at baseline and after the introduction of individual response technology.  | The participants were 59 students in Bachelor of Nursing program at a metropolitan university in Sweden. The students were all enrolled within the same program and were firstyear students.  | Descriptive statistics were used to present means and standard deviations. An independent t-test was used to investigate differences between baseline (T1 P and T1S) and intervention (T2 P andT2S), and apaired-samples t-test was used to analyze differences between baseline and intervention during the pediatric and the statistical lectures. Datawere assumed to be equally distributed, and parametric statistics were therefore appropriate for the analyses. Numericrating scales might be considered to be ordinal, so we also controlledthe analyses using Wilcoxon analyses, with the same results. The statistical analyses were performed using SPSS 21.0 (SPSS for Windows, Rel.15.0.1. 2013. Chicago: SPSS Inc.). The alpha value was set to 0.05. |
| Hincapie, A. L., et al. (2016).Incorporating Health Information Technology and Pharmacy Informatics in a Pharmacy Professional Didactic Curriculum -with a Team-based Learning Approach | To incorporate a pharmacy informatics program in the didactic curriculum of a team-based learning institution and to assess students’ knowledge of and confidence with health informatics duringthe course  | California North state UniversityCollege of Pharmacy | Quantitative  | A previously developed online pharmacy informatics course was adapted and implementedinto a team-based learning (TBL) 3-credit-hour drug information course for doctor of pharmacy (PharmD) students in their second didactic year. During a period of five weeks (15 contact hours), students used the online pharmacy informatics modules as part of their readiness assurance process. Additional material was developed to comply with the TBL principles. Online pre/post surveys wereadministered to evaluate knowledge gained and students’ perceptions of the informatics program. | Eighty-three second-year students (84% response rate) completed the surveys. | Descriptive statistics were used to summarize student demographic information, and McNemar’s test (forNominal variables) or Wilcoxonsigned rank test (for ordinal after the course. All significance calculations were basedon a 95% confidence interval at an alpha of ,0.05. Data analyses were performed using SPSS Statistics, v22.0(SPSS, Inc., Chicago, IL). |
| Johnston, A. N., et al. (2018). Youtube for millennial nursing students; using internet technology to support student engagement with bioscience | The aim of the study was for the clinical bioscience team to develop a series of YouTube videos for use by undergraduate nursing and paramedicine students that are separate from, but integrated into,several large (∼1000 students) undergraduate level bioscience coursesand evaluate the utility of these videos.The primary outcomes of the study, asmeasures of learning resource utility, were access (number of views) and duration of watching time | The study was undertaken in an Australian tertiary education facility, across three regional campuses.Viewers were internationally distributed, and included access from sites in over 60 countries. The top five response sites in terms of total viewing time were Australia - 35%, United States - 22%, India – 8.9%, United Kingdom - 5.2%, and Canada –3.3%.  | Mixed methods | Access data was collected directly from the Biological SciencesYouTube channel. This included identifying the number of channelsubscribers, the number of views and the comments (requested) from students. Data were also collected from standardized university student evaluations of course (SEC) over four semesters, amended to include one question specifically focused around students’ perceptions of theYouTube videos.Qualitative data was drawn directly from the feedback and queries posted on the YouTube site, to help ensure student anonymity and limit perceived impact on curriculum assessment. | The YouTube videos were open access thereforesome responses drawn from the YouTube channel feedback may havebeen from other nursing faculties, enhancing possible transferability ofthe findings.  | Responses were analysed using manual theme identification and concept grouping. These were then synthesised withthe qualitative themes drawn from the University course evaluation documents to enhance interpretative rigour, based on an established framework for evaluation of a multimedia learning resource Developed themes were discussed and agreed amongst theresearchers to gain interrater confirmability and manage reflexivity |
| Little, G. N. (2013) The Effect of a Simulation Experience on Student Perception of Self Confidence | The aim of the study was to determine if participation in a high-fidelity simulation increases studentlevels of self-confidence | This study was conducted at a community college in the southeastern region of the United States. The college simulation laboratory included two separate simulation rooms with two way mirrors and wireless intercom system so that faculty could observe student interaction. The diabetes simulation scenario was conducted using SimMan 3G, which is a high-fidelity simulation manikin. | Quantitative | Students completed a survey indicating self-confidence following the simulation | Thirty-eight (38) first year associate degree nursing studentsenrolled in a medical-surgical course in a South Eastern community college participated in a diabetes simulation as part of their course. | Descriptive statistics were used to determine the overall mean of student responses to each question on the National League for Nursing (NLN) Student Satisfaction and Self Confidence in Learning Tool. |
| Long, J. D., et al. (2016). Effectiveness of a Technology-Based Intervention to Teach Evidence-Based Practice: The EBR Tool. | The purpose of this study was to report the results of the effectiveness of the EBR tool to improve the overall online research and critical appraisal skills of learners engaged in EBP. A web-based, evidence-based research (EBR) tool that is usable from a computer, smartphone, or iPad was developed andtested. The purpose of the EBR tool is to guide students through the basic steps needed tolocate and critically appraise the online scientific literature while linking users to quality electronicresources to support evidence-based practice (EBP).The qualitative research questions sought to understandwhat participants believed about their online research skillsbefore and after use of the EBR tool intervention. | U.S. and Middle East Universities |  Mixed methods | Testing of the tool took place in a mixed-method, quasi-experimental, and two-population randomized controlled trial (RCT) design  | **Arm1: Quasi-experimental**In study arm1, nursing students enrolled in the introductory courses in a RN-BSN (n=72) and MSN (n=63) program in the United States were recruited Fall 2013 to Spring 2014. In Spring 2014, a group of senior BSN students (n = 23) from a private university in the Middle East (ME) was added. **Arms 2 and 3: Two population RCTs.** In arms 2 and 3, recruitment occurred via class announcements from two distinct populations: study arm 2, undergraduate nutrition, and study arm 3, PharmD students. Eighty subjects in the nutrition population and 79 in the pharmacy populationwere enrolled (n=159). | The study data were analyzed using SPSS version 22, mixed-model analysis, with statistical consultation. Demographic, descriptive data, and frequency distributions were determined tomeet assumptions of normality.  |
| Mackay, B. J., et al. (2017).Mobile technology in clinical teaching | To describe the process of introducing teaching innovation, and to explore clinical nurse lecturer perceptions and experience of theuse of mobile smart devices to support student learning | Clinical setting at a regional New Zealand polytechnic.The project team consisted of two researchers and six clinical lecturers from the same nursing department. The clinical lecturers contributed knowledge from the clinical context and worked with the researchers as the project unfolded generating aclimate of collaborative enquiry. | Qualitative | Qualitative descriptive studyThe analysis phase explored six clinical lecturer perceptions andexperience of iPads to support student learning in clinical settings.The participants were a convenience sample of all clinical lecturersWho were allocated iPads as part of the project. All were invited to a focus group interview and asked to keep online reflective journals on a shared portal site.  | The analysis phase explored six clinical lecturer perceptions and experience of iPads to support student learning in clinical settings. The participants were a convenience sample of all clinical lecturers Who were allocated iPads as part of the project.  | The researchers carried out data analysis using the focus group recording and field notes to identify themes. Using a strategy recommended by Harding and Whitehead (2013) two researchers worked independently on the data and then conferred untilagreement was reached.  |
| Todhunter, F. (2015)Using concurrent think-aloud and protocol analysis to explore student nurses' social learning information communication technology knowledge and skill development  | To explore the use of concurrent think-aloud and protocol analysis as a method to examine how student nurses approach ICT.To identify the benefits and challenges of using observational technology to capture learning behaviours.To show the influence of small group arrangement and student interactions on their ICT knowledge and skills development. | First, Second, and Third year student nurses volunteered to participate in the study  | Qualitative | Structuredobservational method through concurrent think-aloud and protocolanalysis | Student nurses undertaking an ICT taskNineteen (19) undergraduate first, second and third-year student nurses volunteered to participate in the study. The first and second yearlearners were organised into five groups of three and according to their year of study. The four third year students were divided intopairs.  | Structured observational analysis using concurrent think-aloud and protocol analysisStructured observational analysis is a pre-determined organised activity used to gather social phenomena. Concurrent think-aloud is the technique used to collect commentary as evidence. Protocol analysis is the process used to examine the spoken thoughts. |
| Van Schyndel, J. L. (2015). Nursing students’ perceptions of presence in online courses | The study measured nursing students’ perception of social, cognitive, and teaching presence in a sample of RN-BSN nursing students taking one specific online course. | The institutional setting from which the sample was obtained was from an accredited nursing program in a Midwest university. The RN-BSN degree from this nursing program offers online nursing courses delivered in eight-week sessions, designedto allow students to continue working while taking classes. Students can be taking theRN-BSN online courses from any of the university’s seven campuses and one campuscenter that offers the RN-BSN program. | Quantitative | This study used a descriptive, correlational design to analyze and evaluate the research questions. The study used an online survey to explore the dimensions of and relationshipsbetween teaching, social, and cognitive presence and student satisfaction with their online course. Additionally, the study assessed if there were associations between students’ perception of the three presences’ subscales, their online course satisfaction, and whether factors related to student characteristics, academic and technology, and the learning strategies used in teaching the online course influenced students’ perceptions. | The convenience sample consisted of RN-BSN nursing students admitted to a nursing degree program and enrolled in a fully online nursing course. Actual recruitment resulted in 76 participants.  | All data were downloaded from Survey Monkey into excel spreadsheets. TheSurvey Monkey items were created in a manner that respondents were required toprovide an answer for each item before they could move on to the next item so there wasno missing data. Data collected from each of the three semesters were combined into oneexcel file. These were then checked for accuracy prior to entering them into the SPSS statistical software package (SPSS, vs 17, Chicago, IL). |
| Vogt, M. A. and B. H. Schaffner (2016). Evaluating interactive technology for an evolving case study on learning and satisfaction of graduate nursing students | The purpose of this study was to evaluate technology enhanced teaching methods on the learning andsatisfaction of graduate students in an advanced pharmacology class using an unfolding case study.Specific research questions included:**** Which technology method best enhances graduate nursingstudent learning?**** How does technology affect graduate nursing student satisfaction with the learning experience? |  | Mixed Methods | A mixed methods approach was used including both quantitative and qualitative data.  | Graduate nursing students enrolled in an advanced pharmacology course were recruited.All forty-six students enrolled in the online course chose to participate in the study. |  |
| Wilkinson, A., et al. (2013)Nursing students' use of technology enhanced learning: A longitudinal study  | The purpose of this study was to explore the experience and confidence of first year pre-registration nursing students with information and communication technologies and technology enhanced learning. | The study site was a large metropolitan university in the UK offering adult, mental health and children’s pre-registrationnursing education. | Quantitative  | A prospective longitudinal survey design with multiple data collection strategies was employed. Cross-sectional surveys using a new ICT and Education Scale at three time-points were used to collect data.  | The target population were first year UK nursing students (n=458); of those 287 (41.7%) participated in the initial baseline survey.The total entry cohort of pre-registration nursing students in the 2004-5 academic year was invited to participate. | Data analysis was conducted using SPSS 12-15 for Windows. Pilot data were used to test the coding frames. Fordemographic variables frequency tables were formed and examined relationships among them using two-way frequencytables and the Pearson Chi-squared test. Researchers also looked at the relationship between key variables: confidence withcomputers; ICT skills; experience with computers and attitudes to ICT in education and the demographic variables. Foreach scale, since all were ordinal researchers used the Mann Whitney and Kruskal Wallis tests as appropriate. Two way ANOVAs were also performed on the ranked scale values to examine the effects of several demographic variables. |