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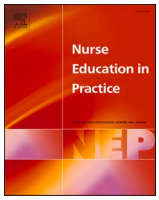

A protocol for a scoping review of the use of mental simulation and full-scale simulation in practising healthcare decision-making skills of undergraduate nursing students

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ABSTRACT

Aim: This scoping review aims to explore the effect of FSS and mental simulation on the decision-making skills of nursing students.
Background: Full-scale simulation (FSS) has been the most used simulation modality in nursing education due to its applicability to enhance both technical and non-technical skills. However, FSS can be excessively costly and other factors such as technophobia and lack of trained staff and support make FSS less accessible, especially for nursing education. Therefore, a novel mental simulation that is interactive and supported by visual elements can be a substitute for FSS, at least for some of the skills, such as clinical decision-making. Reviews comparing the effectiveness of FSS and mental simulation on decision-making skills in nursing students are lacking. Further knowledge on the effectiveness of these two modalities on decision-making skills for nursing students is needed to inform the nursing education curriculum and to decide between the two modalities.
Design: This protocol adheres to the guidelines outlined in the PRISMA extension for scoping reviews (PRISMA-scr) checklist.
Method: The methodological framework for scoping reviews will be followed for this scoping review. Scopus, EBSCOhost the Cumulative Index to Nursing and Allied Health Literature (CINAHL), MEDLINE and for the grey literature ERIC and BASE will be searched for related studies. The search will be limited to January 2008 and April 2023 (up-to-date) and English. A detailed search strategy was developed with an experienced research information manager and this strategy will be adapted to each database. A single screening will be performed by an author who will screen all abstracts and titles and full-text publications. After the study selection step of the framework, the data from the included studies will be charted using a data extraction form. The data will be synthesised by comparing the effect of FSS and mental simulation on decision-making skills.
Conclusion: A synopsis of the publication on FSS and mental simulation on nurse students' decision-making skills will be useful for stakeholders when choosing between two modalities to deliver decision-making skills to nursing students and also help to inform the nursing education and simulation practice.
Scoping Review Registration: Protocols.io (doi: 10.17504/protocols.io.e6nvw57y7vmk/v1)

1. Introduction

Manikin and simulated patient-based simulation, which can also be termed full-scale simulation (FSS), is one of the most effective and commonly used simulation modalities. With the technological development, support available and ease with which these technologies are now used in many institutions, simulation is viewed as an essential part of the current nursing curriculum (Neill and Wotton, 2011; Reed andrews and Ravert, 2013). FSS often includes a human-sized computer-controlled manikin with physiological parameters, which can be modified in response to the clinical scenario and participants' interventions. The voice is generally controlled by an operator, who can 'respond' through a microphone to questions from scenario participants and help convey emotional/psychological responses as a 'simulated' patient response

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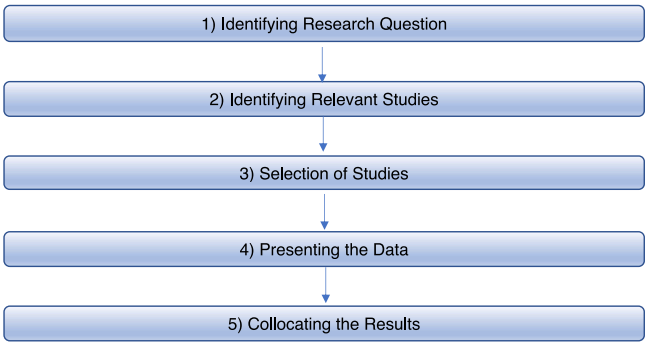

Fig. 1. Proposed approach for scoping reviews (Khalil et al., 2016).

(Hallikainen et al., 2009). There may also be a simulated patient (SP), often an actor, who acts as a real patient in the simulated event so accurately (Lioce et al., 2020). The term 'full-scale simulation' has often been used interchangeably with 'high-fidelity simulation' because it is acknowledged as being high-fidelity due to its lifelikeness with the use of technology, especially when the SP modality is used.

In the nursing literature, many benefits of FSS are described. Evidence suggests that full-scale scenario-based simulation helps to enhance higher-order thinking skills (Jeffries, 2005), provides a link between theory and clinical practice (Neill and Wotton, 2011) and replicates the clinical environments and circumstances that participants are most likely to encounter in clinical practice (Reed et al., 2013). Also, learning experiences related to particular patient situations and interactions can be standardised and repeated by different participants (Warren et al., 2016) to achieve a goal-orientated clinical practice (Neill and Wotton, 2011). Simulation can provide a learner-centred teaching approach within a safe environment ensuring a controlled learning experience without distraction, which might not otherwise occur in the clinical environment where there are many uncontrollable elements (Doolen et al., 2016). For the reasons above, the use of FSS with manikins or SPs has become widespread in the nursing curriculum to teach a variety of skills to nursing students (Alinier et al., 2014; Labrague et al., 2019; Maclean et al., 2017), including decision-making.

However, excessive costs associated with setting up simulation laboratories and manikins, fear of technology, timetabling challenges and lack of support and trained staff have long presented hindrances to the use of FSS in the nursing curriculum more widely (Gantt, 2012; Labrague et al., 2019). Therefore, an affordable, non-technological and interactive solution for practising nursing skills is needed (Alinier et al., 2016; Alinier et al., 2019). Mental simulation, also termed mental-based simulation, which is enhanced with visual elements and interaction, could provide an alternative to full-scale simulation.

Mental simulation is defined as practising an action mentally with the aim of performing it at a later date (Van Meer and Theunissen, 2009). It is a type of simulation which might involve repetition or re-performance. Usually, the person performing the simulation imagines or re-thinks an action or event in detail (Davies, 1994). Mental simulation can be used for developing problem-solving skills and facilitating emotional regulation by imagining actions or events and then taking into consideration potential actions and how the link could be improved between "thought and goal-directed action" (Pham and Taylor, 1999). The logic underlying mental simulation is that when an event is simulated cognitively, the person actively considers their actual or potential behaviours and creates behavioural events by thinking as if they were the main character in a situation (Escalas, 2004). In the healthcare setting this would be the clinicians (nurse, surgeon, physician, etc).

Mental simulation has been used as a warm-up exercise in many fields, including sports and music and has been found to have a significant effect on improving performance (Bernardi et al., 2009; Driskell et al., 1994) and is purported to be a helpful, pragmatic preparatory exercise since it can replace the actual physical rehearsal of the skills (Bernardi et al., 2009; Loimusalo and Huovinen, 2016), which can require time and necessitate specific, physical spaces. In healthcare, the use of mental simulation has been studied widely in relation to technical skills such as laparoscopic skills (Arora et al., 2011; Paige et al., 2015), epidural catheterisation (Lim et al., 2016) and other domains (Anton et al., 2017) as well as non-technical skills such as decision-making (Nathwani et al., 2017) and management skills (Hayter et al., 2013). Mental simulation was found to not only improve performance, but also boost practitioners' confidence (Paige et al., 2015) and diminishes stress levels (Ignacio et al., 2016).

However, mental simulation approaches generally used involve an individual task in which practitioners, on an individual basis, follow the steps by reading the steps of written instructions and rehearsing the actions/processes of care in their mind (Davison et al., 2017; Sevdalis et al., 2013; Wallace et al., 2017). It has been argued that if this approach is additionally supported by visual elements, it will positively affect the thinking process (Clark et al., 2012; Yiasemidou et al., 2018, 2017). These external visual elements, along with the think-aloud approach, which involves verbalising thought and action when it occurs in the mind (Downs and Halls, 2020), enable group learning and the practise of non-technical skills. Mental simulation supported by visual elements, thinking aloud and facilitation can arguably provide a replacement or substitution for FSS when rehearsing certain skills, such as teamwork and decision-making. This method is termed *Visually Enhanced Mental Simulation* (VEMS) (Alinier et al., 2016; Dogan et al., 2021). VEMS is a combination of mental simulation, thinking aloud and visual representation of equipment and a simulated patient scenario to support participants to cognitively process and articulate their intended actions. It provides an interactive mental simulation in that participants can interact with patients and colleagues.

2. The rationale for the scoping review

Mental simulation has great potential to enhance students' decision-making skills, particularly if developed with some visual cues and if formally facilitated (Dogan et al., 2021) and can be used as a method to teach non-technical skills in healthcare. VEMS could offer an alternative or complementary approach to FSS, which is expensive, resource-intensive and more complex to set up (Ziv et al., 2000). Therefore, exploring the impact and effectiveness of these two methods on a key cognitive process, decision-making (and associated decision-making skills), is important for deciding on the adoption of either of these two modalities.

The objective of this review is to investigate the evidence for FSS and mental simulation on nursing students' decision-making skills and explore the potential use of an adapted form of mental simulation, VEMS, in nursing educational curricula.

A scoping review was deemed a suitable approach to summarise and disseminate research findings on the use of an adapted form of mental simulation (VEMS) and FSS to develop decision-making skills and to identify the research gap across the nursing literature. Moreover, due to the range of study designs used in simulation studies of this type (mainly observational, with a lack of controlled trials), a scoping review seemed to most appropriate method (Arksey and O'Malley, 2005).

This article is written as a protocol and outlines the methods and steps taken, including eligibility criteria, search sources and strategies, selection of evidence, data charting and evidence synthesises and analysis, to address the objective of this scoping review.

3. Method

The methodological framework proposed by Arksey and O'Malley (2005) which was extended later (Khalil et al., 2016; Levac et al., 2010) will be followed (Fig. 1).

This protocol is written according to the PRISMA extension for scoping reviews (PRISMA-scr) checklist (Tricco et al., 2018) (Appendix

1). The protocol has been registered with the Protocols.io (doi: 10.17504/protocols.io.e6nvw57y7vmk/v1).

3.1. Eligibility criteria

In this review, qualitative and quantitative studies evaluating the decision-making skills of undergraduate nursing students and using full-scale simulation with computer-controlled manikins and/or standardised patient and mental simulation as the intervention will be included. Additionally, mental simulation studies that include visual elements will be included. The search will be limited from January 2008 to April 2023. All empirical peer-reviewed journal articles will be considered for inclusion in the review. Non-research study designs such as non-systematic reviews, discussion/opinion papers, guidelines, editorials and letters will be excluded. Studies must have an abstract and a clearly stated aim for inclusion. Only studies published in English will be considered. Detailed inclusion and exclusion criteria for the scoping reviews are specified as population, intervention, outcome and sources of evidence (Appendix 2).

3.2. Information sources and search strategy

A search strategy (Appendix 2) was created using MeSH terms and keyword combinations. The search strategy will be adapted to each database. The search will be made using Scopus, the Cumulative Index to Nursing and Allied Health Literature (CINAHL) and MEDLINE in EBSCOhost and for the grey literature ERIC and BASE from January 2008 to April 2023 (up to date). The reference lists of included studies will be scanned for other studies of relevance. The search will be rerun before the final analysis to identify any relevant new research for inclusion.

A comprehensive search strategy for EBSCOhost MEDLINE was developed together with an experienced research information manager (RC, BD) (Appendix 4). Each of the search concepts was mapped out as nursing students, decision-making skills, full-scale simulation and mental simulation and their synonyms were included in the keywords for each concept. The search was planned using exact phrase searching, truncation and proximity searching (Appendix 2).

Due to the iterative nature of the scoping review (Arksey and O'Malley, 2005; Khalil et al., 2016; Levac et al., 2010), the initial search result will be evaluated and any improvement needs will be considered. In case of any changes in the protocol, this will be reported.

3.3. Selection of sources of evidence

The title and abstract will be single screened by an investigator (BD). A single screening of the title and abstract will be held by an investigator (BD). If the reviewer is not sure about the inclusion of a study, another reviewer (GA) will be consulted and if any agreement could not be reached, a third reviewer (NP) will be contacted to get advice. The full text of citations selected by the reviewer for potential inclusion will be imported into to Mendeley Desktop Reference Management Program (Mendeley, 2021) and assessed for eligibility. Excluded full-text articles will be presented in an appendix explaining the reasons for exclusion. A PRISMA study flow diagram (Moher et al., 2009) will be completed to describe the search results.

3.4. Data charting process

The data will be extracted using a specifically designed form (Appendix 3). The review investigator (BD) will read and extract the data from the included studies using the data extraction form. The form will capture the country of the study, study design, participants, aim of the study, simulation scenario, outcome measures or themes and key findings. Also, it will allow the investigator to make additional observations as necessary. The data on the type of simulation modality used and how the intervention affected decision-making skills will be extracted including outcome measures used. The corresponding authors of the included studies will be contacted for missing information as needed.

3.5. Evidence synthesis, analysis and interpretation

The characteristics of the included studies, including the study setting and outcome of the study will be summarised. The studies will be grouped according to the study types and presented in the data table. The simulation modalities used will be summarised with reported barriers.

The effect of the intervention on the outcome measures selected for each study, including any decision-making-related outcomes (i.e. critical thinking, problem-solving, clinical judgement, critical reasoning) will be reported. The simulation session conducted and outcome measures and participants' opinions on the sessions (if the study involved qualitative methods), will be described. Data extraction categories and outcomes will be compared for FSS and MS and consolidated across the included studies. The evidence will be reported based on the PRISMA for scoping reviews (PRISMA-ScR) (Tricco et al., 2018).

4. Discussion

Although FSS is acknowledged as an important educational tool to learn and rehearse clinical skills, it can be difficult to embrace the technology often associated with this modality due to its excessive cost, technophobia, resource implications and insufficiently trained staff (Gantt, 2012; Labrague et al., 2019). Alternative simulation modalities to enable running scenarios without these hindrances are needed (Alinier et al., 2016, 2019). Visually enhanced mental simulation could provide a platform to practise decision-making skills by using visual cues during simulated scenarios (Dogan et al., 2021).

This scoping review will provide comprehensive information on the literature that exists in nursing simulation education that adopted FSS and/or mental simulation. This review will map out the evidence on the effect and impact of FSS and mental simulation on the decision-making skills of nursing students and the finding of this review will inform the applicability of mental simulation to decision-making skills rehearsal in nursing education and its comparison to FSS. Moreover, the scoping review will investigate the knowledge gap in the literature where further primary research or systematic reviews are needed. Although there are some studies investigating the effectiveness of FFS on non-technical skills (Abdulmohdi and Mcvicar, 2023; Akalin and Sahin, 2020; Ayed et al., 2021; Bussard, 2018; El Hussein and Hirst, 2023; Lapkin et al., 2010; Salameh et al., 2021; Svellingen et al., 2021), to our knowledge none have compared FSS and mental simulation enhanced with visual cues. A transparent and reproducible research procedure can inform the nursing education stakeholders in both clinical and academic settings and will inform simulation practice that can suggest a substitution or supplementary method to FSS. Because the nature of scoping review is iterative, the research strategy and the search terms may be amended and expanded. This will be reported in the main scoping review report.

Funding sources

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Declaration of Competing Interest

none.

Acknowledgements

none.

Appendix 1

Preferred Reporting Items for Systematic reviews and Meta-Analyses extension for Scoping Reviews (PRISMA-ScR) Checklist

SECTION	ITEM	PRISMA-ScR CHECKLIST ITEM	REPORTED ON PAGE #
TITLE			
Title	1	Identify the report as a scoping review.	1
ABSTRACT			
Structured summary	2	Provide a structured summary that includes (as applicable): background, objectives, eligibility criteria, sources of evidence, charting methods, results, and conclusions that relate to the review questions and objectives.	1
INTRODUCTION			
Rationale	3	Describe the rationale for the review in the context of what is already known. Explain why the review questions/objectives lend themselves to a scoping review approach.	4
Objectives	4	Provide an explicit statement of the questions and objectives being addressed with reference to their key elements (e.g., population or participants, concepts, and context) or other relevant key elements used to conceptualize the review questions and/or objectives.	5
METHODS			
Protocol and registration	5	Indicate whether a review protocol exists; state if and where it can be accessed (e.g., a Web address); and if available, provide registration information, including the registration number.	5
Eligibility criteria	6	Specify characteristics of the sources of evidence used as eligibility criteria (e.g., years considered, language, and publication status), and provide a rationale.	7
Information sources*	7	Describe all information sources in the search (e.g., databases with dates of coverage and contact with authors to identify additional sources), as well as the date the most recent search was executed.	7
Search	8	Present the full electronic search strategy for at least 1 database, including any limits used, such that it could be repeated.	7
Selection of sources of evidence†	9	State the process for selecting sources of evidence (i.e., screening and eligibility) included in the scoping review.	7
Data charting process‡	10	Describe the methods of charting data from the included sources of evidence (e.g., calibrated forms or forms that have been tested by the team before their use, and whether data charting was done independently or in duplicate) and any processes for obtaining and confirming data from investigators.	8
Data items	11	List and define all variables for which data were sought and any assumptions and simplifications made.	8
Critical appraisal of individual sources of evidence§	12	If done, provide a rationale for conducting a critical appraisal of included sources of evidence; describe the methods used and how this information was used in any data synthesis (if appropriate).	N\A
Synthesis of results	13	Describe the methods of handling and summarizing the data that were charted.	8

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SECTION	ITEM	PRISMA-ScR CHECKLIST ITEM	REPORTED ON PAGE #
RESULTS			
Selection of sources of evidence	14	Give numbers of sources of evidence screened, assessed for eligibility, and included in the review, with reasons for exclusions at each stage, ideally using a flow diagram.	
Characteristics of sources of evidence	15	For each source of evidence, present characteristics for which data were charted and provide the citations.	
Critical appraisal within sources of evidence	16	If done, present data on critical appraisal of included sources of evidence (see item 12).	
Results of individual sources of evidence	17	For each included source of evidence, present the relevant data that were charted that relate to the review questions and objectives.	
Synthesis of results	18	Summarize and/or present the charting results as they relate to the review questions and objectives.	
DISCUSSION			
Summary of evidence	19	Summarize the main results (including an overview of concepts, themes, and types of evidence available), link to the review questions and objectives, and consider the relevance to key groups.	8
Limitations	20	Discuss the limitations of the scoping review process.	8
Conclusions	21	Provide a general interpretation of the results with respect to the review questions and objectives, as well as potential implications and/or next steps.	8
FUNDING			
Funding	22	Describe sources of funding for the included sources of evidence, as well as sources of funding for the scoping review. Describe the role of the funders of the scoping review.	9

JBI = Joanna Briggs Institute; PRISMA-ScR = Preferred Reporting Items for Systematic reviews and Meta-Analyses extension for Scoping Reviews.
* Where *sources of evidence* (see second footnote) are compiled from, such as bibliographic databases, social media platforms, and Web sites.
† A more inclusive/heterogeneous term used to account for the different types of evidence or data sources (e.g., quantitative and/or qualitative research, expert opinion, and policy documents) that may be eligible in a scoping review as opposed to only studies. This is not to be confused with *information sources* (see first footnote).
‡ The frameworks by Arksey and O'Malley (6) and Levac and colleagues (7) and the JBI guidance (4, 5) refer to the process of data extraction in a scoping review as data charting.
§ The process of systematically examining research evidence to assess its validity, results, and relevance before using it to inform a decision. This term is used for items 12 and 19 instead of "risk of bias" (which is more applicable to systematic reviews of interventions) to include and acknowledge the various sources of evidence that may be used in a scoping review (e.g., quantitative and/or qualitative research, expert opinion, and policy document).

From: Tricco AC, Lillie E, Zarin W, O'Brien KK, Colquhoun H, Levac D, et al. PRISMA Extension for Scoping Reviews (PRISMAScR): Checklist and Explanation. Ann Intern Med. 2018;169:467–473. doi: 10.7326/M18-0850.

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Appendix 2

The Search Strategy

A systematic search will be undertaken between January 2019 to April 2023 in order to conduct a scoping review on the effect of immersive and mental simulation-based learning on nurses' decision-making and non-technical skills. MEDLINE, Cumulative Index to Nursing and Allied Health Literature (CINAHL Plus), and Scopus databases have been searched for this purpose. Boolean operators (AND, OR, NOT) and search functions were used to expand or restrict the search.

Research inclusion criteria for "full-scale simulation" and "decision making" and "nurse students" search:
Population: undergraduate nurse students.
Intervention: simulation used full-scale simulation (standardised patient or manikin based-simulation).
Outcome: Decision-making skills.
Types of sources of evidence: All systematic reviews analysed full-scale simulation effect on decision-making skills,
Experimental Studies on full-scale simulation effectiveness in decision-making skills,
Studies in English.
Studies published from January 2008 to April 2023.
Research inclusion criteria for "mental simulation" search:
Population: All nurse students.
Intervention: mental simulation.
Outcome: Decision-making skills.
Types of sources of evidence: Systematic reviews analysed mental simulation effect on decision-making skills,
Experimental Studies on mental simulation effectiveness in decision-making skills,
Studies used visual elements in mental simulation.
Studies in English.
Studies published from January 2008 to April 2023. Table A1.

Table A1
research concept and its synonym keywords for literature search.

"Undergraduate* nurs* "	"Full-scale simulation"	"Mental Simulation"	"Decision-making skills"
"Nurs* student"	"High fidelity simulation"	"Mental rehearsal"	"Critical thinking"
"Pre-registration nurs* "	"Patient simulation"	"Mental practi*e"	"Clinical decision making"
"Prelicensure nurs* "	"Human simulation"	"Mental imagery"	"Clinical judgement"
"baccalaureate* nurs* "	"Full-scale simulation"	"Cognitive imagery"	"Clinical reasoning"
"nurs* degree* "	"simulation Training"	"Cognitive training"	"Problem-solving"
"nurs*educat* "		"Mental training"	"Cognitive skills"

Appendix 3. Data Chart

Author (Year)	Country of the study	Study Design and participants	Aim of the study	Simulation scenarios/	Outcome measured/ themes	Key findings	Notes

Appendix 4. EBSCOhost MEDLINE search strategy

Search ID#	**Search Terms**	**Search Options**	**Actions**
	S22	S19	**Limiters** - Date of Publication: 20080101–20230431 **Expanders** - Apply equivalent subjects **Narrow by Language:** - english **Search modes** - Boolean/Phrase
	S21	S19	**Limiters** - Date of Publication: 20080101–20230431 **Expanders** - Apply equivalent subjects **Search modes** - Boolean/Phrase
	S20	S19	**Expanders** - Apply equivalent subjects **Search modes** - Boolean/Phrase
	S19	S14 OR S18	**Expanders** - Apply equivalent subjects **Search modes** - Boolean/Phrase
	S18	S9 AND S10 AND S17	**Expanders** - Apply equivalent subjects **Search modes** - Boolean/Phrase
	S17	S15 OR S16	**Expanders** - Apply equivalent subjects **Search modes** - Boolean/Phrase
	S16	cognitive N2 (training OR imagery)	**Expanders** - Apply equivalent subjects **Search modes** - Boolean/Phrase
	S15	"Mental rehearsal* " OR "mental practi*e" OR "mental simulation" OR "mental training" OR "mental skills" OR "mental imagery") OR (MH "Imagination") OR ((MH "Mental Processes" AND MH "Learning"))	**Expanders** - Apply equivalent subjects **Search modes** - Boolean/Phrase
	S14	S9 AND S10 AND S13	**Expanders** - Apply equivalent subjects **Search modes** - Boolean/Phrase
	S13	S11 OR S12	**Expanders** - Apply equivalent subjects **Search modes** - Boolean/Phrase
	S12	simulation N1 (training OR patient OR human OR "high-fidelity" OR "full-scale")	**Expanders** - Apply equivalent subjects **Search modes** - Boolean/Phrase

(*continued on next page*)

(*continued*)

Search ID#	Search Terms	Search Options	Actions
	S11	(MH "Patient Simulation") OR (MH "Simulation Training+") OR (MH "High Fidelity Simulation Training")	**Expanders** - Apply equivalent subjects **Search modes** - Boolean/Phrase
	S10	S4 OR S5 OR S6 OR S7 OR S8	**Expanders** - Apply equivalent subjects **Search modes** - Boolean/Phrase
	S9	S1 OR S2 OR S3	**Expanders** - Apply equivalent subjects **Search modes** - Boolean/Phrase
	S8	(MH "Clinical Decision-Making+")	**Expanders** - Apply equivalent subjects **Search modes** - Boolean/Phrase
	S7	(MH "Clinical Reasoning") OR (MH "Clinical Competence/ST") OR (MH "Task Performance and Analysis+")	**Expanders** - Apply equivalent subjects **Search modes** - Boolean/Phrase
	S6	"problem solving" OR "critical thinking" OR "cognitive skills" OR "clinical competenc* " OR "improve* perform* " OR "enhance* perform* "	**Expanders** - Apply equivalent subjects **Search modes** - Boolean/Phrase
	S5	clinical N2 (judgement OR reasoning)	**Expanders** - Apply equivalent subjects **Search modes** - Boolean/Phrase
	S4	("decision making") N2 (skills OR clinical)	**Expanders** - Apply equivalent subjects **Search modes** - Boolean/Phrase
	S3	(MH "Education, Nursing, Baccalaureate")	**Expanders** - Apply equivalent subjects **Search modes** - Boolean/Phrase
	S2	(MH "Students, Nursing") OR (MH "Education, Nursing+")	**Expanders** - Apply equivalent subjects **Search modes** - Boolean/Phrase
	S1	(nurse*) N2 (educat* OR undergrad* OR prelicensure OR pre-regis* OR degree* OR baccalaureate* OR curricul* OR novice* OR trainee* OR student*)	**Expanders** - Apply equivalent subjects **Search modes** - Boolean/Phrase

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