Clinical Reasoning in Undergraduate Primary Care Medical Education: A Systematic Review (BEME Reg. No. 0139)

Reviewers:

1. **Dr Nur Faraheen Abdul Rahman – Lead reviewer**

   i) Research Department of Primary Care and Population Health,
   University College London,
   Upper 3rd floor, Royal Free Hospital
   Rowland Hill Street, London
   NW3 2PF United Kingdom

   ii) Department of Primary Care
   Universiti Sains Islam Malaysia
   Faculty of Medicine and Health Sciences
   Level 13, Tower B, Bangunan MPAJ
   Jalan Pandan Utama, Pandan Indah
   55100 Kuala Lumpur, Malaysia
   Email: Nur.rahman.19@ucl.ac.uk

2. Dr Nathan Davies
   Research Department of Primary Care and Population Health,
   University College London,
   Upper 3rd floor, Royal Free Hospital
   Rowland Hill Street, London
   NW3 2PF United Kingdom
   Email: N.m.davies@ucl.ac.uk

3. Dr Julia Suhaimi
   Department of Primary Care Medicine
   Universiti Malaya Medical Centre
   Jalan Universiti
   59100 Kuala Lumpur, Malaysia
   Email: Julia.suhaimi@ummc.edu.my

4. Dr Sharifah Najwa Syed Mohamad
Department of Primary Care
Faculty of Medicine and Health Sciences
Universiti Sains Islam Malaysia
Level 13, Tower B, Bangunan MPAJ
Jalan Pandan Utama, Pandan Indah
55100 Kuala Lumpur, Malaysia
Email: shnajwa@usim.edu.my

5. Dr Faridah Idris
Department of Pathology
Faculty of Medicine and Health Sciences
Universiti Putra Malaysia
43400 Serdang Selangor, Malaysia
Email: i_faridah@upm.edu.my

6. Dr Sophie Park
Research Department of Primary Care and Population Health,
University College London,
Upper 3rd floor, Royal Free Hospital
Rowland Hill Street, London
NW3 2PF United Kingdom
Email: Sophie.park@ucl.ac.uk

Dr Nur Faraheen Abdul Rahman (NFAR) is a PhD student (Primary Care and Population Health) supervised by Dr Sophie Park and Dr Nathan Davies at the Research Department of Primary Care and Population Health, University College London. She is a General Practitioner with a Master in the Health Professions Education from Maastricht University, the Netherlands in 2016. She is also a senior lecturer in Family Medicine and an active member in the Medical Education Unit, Universiti Sains Islam Malaysia. She is also a co-researcher for the Patient and Public Involvement in Medical Education (INVOLVE-ME) Malaysia. Her PhD project is an extension to her unpublished

MHPE thesis “Deliberate practice in clinical reasoning teaching and learning in undergraduate primary care”.

Dr Nathan Davies (ND) is a Senior Research Fellow (Research Department of Primary Care and Population Health) at the University College London. He is Deputy Director for the Centre for Ageing Population Studies. His work focusses on decision making, dementia and end of life care.

Dr Julia Suhaimi (JS) is a senior lecturer and family medicine specialist from University of Malaya. She is the department’s joint coordinator for the undergraduate programme. Her research interest is on adolescent and women’s health. She has participated in many research projects and is the co-author of a systematic review on self-management school-based intervention for asthma among primary school children.

Dr Sharifah Najwa Syed Mohamad (SNSM) is an early career researcher, medical lecturer and Clinical Family Medicine Specialist at the Universiti Sains Islam Malaysia. Her research interests are mainly in women’s and children/adolescent health. She has co-authored a systematic review on “Computer-based remedial programs for primary school children diagnosed with dyslexia: Results from MEDLINE”.

Dr Faridah Idris (FI) is a senior medical lecturer and a clinical haematopathologist in the Department of Pathology, Faculty of Medicine and Health Sciences, Universiti Putra Malaysia. She has certificate in curriculum and instruction from Maastricht University, Netherlands in 2018 and is an active member in the Medical Education Research and Innovation Unit (MERIU), UPM Her research interest in medical education is in Team-based learning (TBL), e-learning and has been doing collaborative work with ACOrD - Advancing Co-creation of RLOs (Reusable Learning Objects) to Digitalize Health Curricula team, a project co-funded by the Erasmus+ Programme of the European Union, 2018-2021 and led by University of Nottingham, UK.

Professor Dr Sophie Park (SP) is Director of Medical Education (Primary Care and Community) at UCL Medical School. She is a GP and a Professor. Sophie Park was awarded Highly Commended for the RCGP & SAPC Yvonne Carter Award 2015 for innovative work in developing a distinct body of educational research in primary care. Sophie is National Chair of the Society of Academic Primary Care (SAPC) Education Research Group, and the UCL primary care education research group. She is also Co-Director of the London BICC: a Best Evidence in Medical Education (BEME) International Collaboration Centre, and member of the BICCs international Education Committee. Sophie is UCL Lead & Workstream 4.0 Co-Lead for the NIHR School of Primary Care Research (SPCR) Evidence Synthesis Working Group (ESWG). Within this, she is also PI for an on-going realist review of delegated GP home visits. She is Co-Lead of the SPCR 'Organisation and Delivery of Primary Care' working group and ESWG Training Co-Lead.

Sources of support: This review is supported by funding from the Ministry of Education Malaysia and Universiti Sains Islam Malaysia, awarded to Dr Nur Faraheen Abdul Rahman.

Abstract

Introduction In this protocol, we describe the systematic review plan for clinical reasoning in undergraduate primary care education. Clinical reasoning is the thinking and other related processes that leads to decision-making and is a key professional competency. Primary health care has a well-integrated element of patient-based care in addition to disease oriented practice, and is an essential quality that differentiates it from the hospital-based care. General practitioners are the gatekeepers to the health care system and are at the forefront of using clinical reasoning to make decisions. Medical students are expected to learn the complexity of clinical reasoning within this setting during their clinical clerkship. The implications of situated clinical reasoning teaching and learning is unclear. Guided by the theory of transformative learning, learning activities, concepts, and characteristics, facilitators and barriers, roles of various stakeholders, and outcomes of clinical reasoning education process and practice within the primary care setting will be explored.

Method A narrative synthesis will be conducted using meta-synthesis methods to analyse and interpret findings from reported qualitative, quantitative and mixed-method studies from several databases.

Practical implications of findings This review has the potential to increase understanding on clinical reasoning teaching and learning in the work-place based primary care clerkship, guide local undergraduate clinical reasoning education, and highlighting ways to engage with relevant stakeholders involved in this important learning endeavour.

2. Background

Undergraduate students are novices in the medical field. Within 4 to 6 years, medical students learn “knowing that” (declarative knowledge) and “knowing how” (procedural knowledge) of patients, diseases, and the system of healthcare. Students achieve declarative knowledge through learning the facts of biomedical knowledge. Students apply the biomedical knowledge to patient’s problems through clinical reasoning (Lucey, 2013). Learning clinical reasoning is important because it is the core component of being a doctor, the role of making the right diagnosis, and other relevant decisions, so that patient’s illness is managed correctly and safely.

A precise definition of clinical reasoning has proved elusive. Eva (2005) used a competency-based framework to identify seven abilities that might be subsumed under the term clinical reasoning. These abilities:

> *'often entail careful observation, appropriate elicitation of historical information, accurate performance of physical manoeuvres, the generation of hypotheses, and appreciation of the relationship between each piece of data and each hypothesis and attempting to confirm/disconfirm hypotheses through the appropriate ordering of diagnostic tests' (Eva, 2005).*

Durning and his colleagues described clinical reasoning as characterised by "*the mental processes and behaviours that are shared (or evolve) between the patient, clinician, and the practice setting environment*" (Durning et al., 2010). In other words, clinical reasoning involves not only cognitive efforts, but also affective and conative elements bounded by interplays among the participants of reasoning in their distinctive surroundings (Durning, Artino, Schuwirth, & van der Vleuten, 2013).

Young and colleagues (2018), in an international collaborative paper elucidated clinical reasoning as the process of "gathering and synthesising information; generating hypotheses; and formulating a clinical impression, prognosis, diagnosis, treatment, care, or management plan". Although differences of opinion still exist. There appears to be some agreement that clinical reasoning refers to processes that form its meaning. To this end, Young and colleagues (2018) concluded that it is unavoidable that the definition of clinical reasoning will be dominated by "areas of focus that resonate with (one's) explicit and implicit conceptions of clinical reasoning".

Historically, clinical reasoning has been discussed extensively under the banner of clinical decision-making and medical error (Norman, 2005). Existing research recognised the critical role played by clinical reasoning, particularly from the perspective of neurocognitive science and cognitive psychology and in the area of expertise development. In medical education, clinical reasoning has evolved from being studied predominantly through laboratory experiments to practice-based research, including in primary care setting. The research to date has tended to focus on clinical reasoning among general practitioners (stolper, Issen). Few studies have

investigated clinical reasoning in undergraduate primary care medical education in a systematic way.

Clinical reasoning in primary care is complex (Issen). GPs often deal with uncertainties of patient's multimorbid presentations. Unlike decisions made in secondary care, where decisions are made as part of a multi-disciplinary team, many decisions made in primary care are made solely by the GP. (Considine, Botti, & Thomas, 2007; Pelaccia et al., 2019, 2016). GPs not only will have to rely on their ability to reason but also incorporate even wider arrays of information through social interactions. As the first point of care, the decisions made by GPs are crucial, particularly in terms of timely management. The diversity and range of decisions made in the primary care setting: from diagnosing to organising social care for patients to training medical students; provide a complex decision-making space in which clinical reasoning can be explored. How clinical reasoning differs in this regard is worth investigating.

Students learn clinical reasoning during the undergraduate years by exposure to patient's problems in forms of representation of cases (Braun et al., 2017), with simulated (Kopp, Stark, & Fischer, 2008), virtual (Hege, Kononowicz, Kiesewetter, & Foster-Johnson, 2018) or real patients , informally (implicit) (Ark, Brooks, & Eva, 2006) or through structured modules (explicit) (Bösner, Pickert, & Stibane, 2015), and in various learning settings (Norman, 2005). The exposure to clinical reasoning is essential, particularly at the undergraduate level as studies have shown that how students were taught in the undergraduate years, determined their ways of practicing medicine (Kiesewetter et al., 2020), including making cost-conscious effort of investigating patient's clinical presentations (Dornan et al., 2006)(Gillespie et al., 2018).

Because clinical reasoning is conceptualised through the interactions of participants involved in reasoning, it is paramount to consider how stakeholders in the triadic relationship of student-clinical teacher-patient (Noble et al, 2019) have played and will continue to assert their role in this learning process. An important stakeholder in clinical reasoning education are the clinical teachers that deliver and model clinical reasoning to medical students (Barber et al., 2019). Clinical teachers, as the subject experts, operate on a presumably more efficient level of clinical reasoning ability (S.

Durning, Artino, Pangaro, van der Vleuten, & Schuwirth, 2011). As experts of clinical reasoning (Brush, Sherbino, & Norman, 2017), it will be interesting to explore how clinical teachers have been supporting student's learning of clinical reasoning competency through various learning activities in literature.

Patients are another stakeholders in the triadic relationship. There has been increasing interests to investigate the effects of them partaking in medical education including on their health outcomes (Towle, 2006). Studies of patient's participation in medical education has examined level of patient's involvement, in designing, reviewing, or assessing clinical training (Szumacher, 2019). Central to clinical reasoning and decision-making is concerning patient's preference and circumstances. Despite that, there remains a paucity of evidence on patients' roles in shaping clinical reasoning medical education.

Why is this review important?

Two systematic reviews have formed the basis for the current systematic review. The first was an expert review of clinical reasoning teaching and learning that summarised past research and future directions of this topic (Norman, 2005). The second was a systematic review of undergraduate teaching and learning in the primary care setting (Park et al., 2015) that helped to identify important characteristics of the primary care setting as a unique teaching and learning environment.

This systematic review may be utilised by medical educators, primary care clerkship program coordinators and curriculum designers to make informed choices as to what could work best in their local context.

This review is important to:

1) Understand how clinical reasoning is characterised in the literature through description of approaches to learning and teaching
2) Uncover various theories used to underpin the learning and teaching activities
3) Identify important strengths and weaknesses of teaching and learning clinical reasoning in this setting
4) Recognise, position and highlight the roles of different stakeholders involved in the process

The current review will be the first attempt to review the overlapping interests of clinical reasoning and undergraduate primary care education. Further, this review will highlight roles of stakeholders involved in clinical reasoning in undergraduate medical education. Despite undergraduate training being the main focus, it can also help navigate postgraduate and continuous learning of clinical reasoning education of health care professionals in the primary care setting.

Theoretical framework

Guided by the theory of transformative learning (Mezirow, 2003) this review will explore the clinical reasoning teaching and learning within the context of workplace-based undergraduate primary care education. In this theory, the adult learner in their own capacity, make meaning of their experiences through examination, question, validation and revision of one's beliefs attitudes and feelings. Interpretations of experiences are called "meaning structures" and these include points of view, habits of mind and frame of reference. Often the transformed points of view are challenged through a dilemma or a crisis, as the learner interacts with other stakeholders and the workplace environment. Transformative learning was the theoretical lens with which review questions were formed and with which the data from the included papers sampled will be analysed and synthesised.

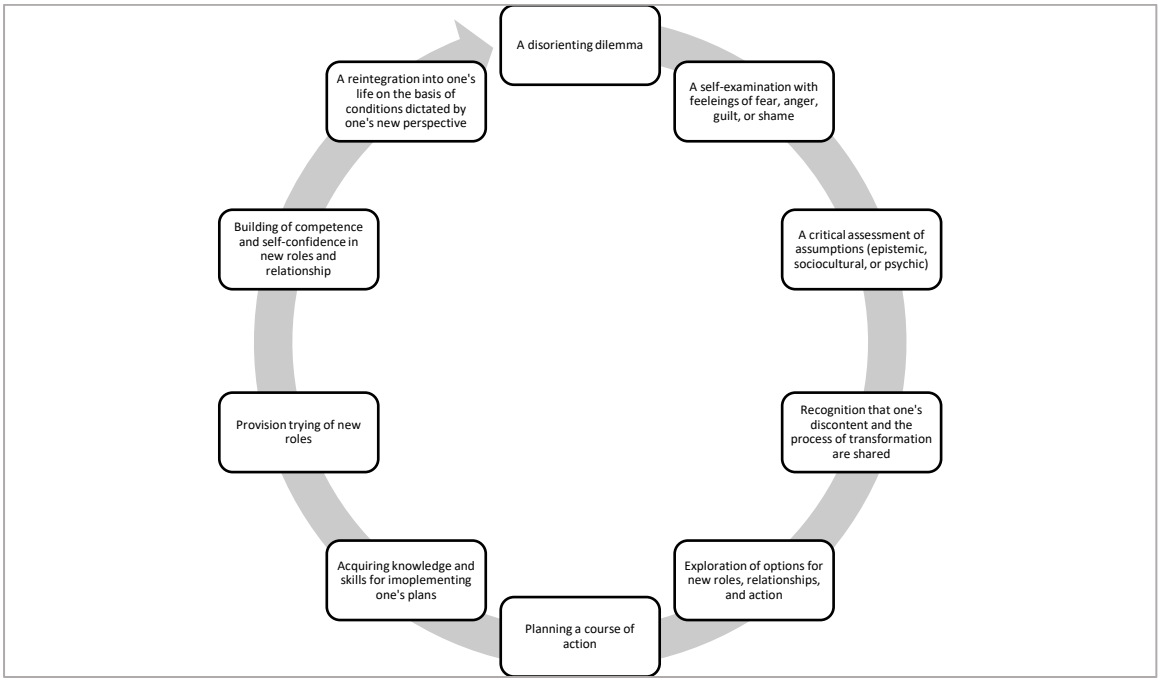

Figure 1: Ten steps of transformative learning (Mezirow, 2003)

3. Review topic/ questions, objectives and keywords

This review aims to identify and describe the educational activities, barriers to and facilitators for clinical reasoning teaching and learning in undergraduate primary care medical education.

Review questions

1. What educational activities are described in the international literature on clinical reasoning in undergraduate primary care medical education?
2. What are the theoretical frameworks that underpin the educational activities used for clinical reasoning in the undergraduate primary care setting?
3. Who are the stakeholders involved and what are their roles in undergraduate clinical reasoning teaching within the context of primary care?
4. What is the role and level of involvement (design, review, evaluation etc.) of patients in clinical reasoning undergraduate primary care training?
5. What are the facilitators and barriers to medical undergraduate teaching and learning of clinical reasoning in the undergraduate primary care?
6. What outcomes are reported about the teaching and learning of clinical reasoning as well as of the stakeholders that were involved in undergraduate primary care medical education?

Keywords

Guided by a modified PICO, and initial scoping work of relevant literature the following keywords were identified:

Participants: Undergraduate medical students
Intervention: Clinical reasoning and other related keywords
Context: Clinical clerkship, Primary health care medical education
Outcomes:
Types of educational activities used for clinical reasoning

Stakeholder's role and influence on clinical reasoning education
Experiences of learning/teaching, knowledge/skills/attitude change among students, clinical teachers and patients

After several rounds of consultations with an information specialist, an expanded list of final keywords used for search can be found in Appendix A.

4. Search sources and strategies

Electronic databases MEDLINE, EMBASE, PsycINFO, CINAHL and ERIC databases will be searched. Reference lists and citations of included papers will be tracked to identify additional literature not identified in electronic searches. Key authors in the fields will also be contacted to include other articles not initially captured from the database searches. The literature search will be carried out by NFAR assisted by an information specialist using Boolean operators. Appendix A provides the full search strategy using MEDLINE and reciprocated with the remaining databases.

5. Study selection criteria

a) Inclusion criteria

- Participants: Undergraduate medical students.
- Studies that investigated workplace-based experiential learning and other teaching activities done for clinical reasoning education in primary health care setting during the clerkship.
- Language: English
- Year: 2010 until 2020. The review focused on the past 10 years as this marks a period of time since the introduction of competency-based medical education (CBME) where there was an increase in clinical reasoning education. Using the last 10 years of data sampling emphasised the relevance of this review to current policies, processes and practices within the theoretical and empirical domains for this topic.

b) Exclusion criteria

- Studies that focus on post-graduate students, residents, clinicians, other non-medical students and practitioners (nurses, physiotherapists, occupational therapists, speech therapists, pharmacists, medical assistants, veterinarians etc.).
- Studies that describe cases as evidence for clinical reasoning not meant for medical education of the undergraduate students.
- Studies that include learning activities using sources (such as patient cases) found in general practice but conducted outside the primary care clerkship.
- Editorials, book reviews, unpublished theses, proceeding abstracts, bibliographies, resource or policy documents, letters, expert opinions etc.
- Studies that were not relevant to the review objectives.

Following de-duplication, NFAR will independently screen and review all titles and abstracts, a random selection of 20% will be checked jointly checked by JS, SNSM and FI. Any disagreement will be resolved by discussion with SP or ND. To ease this process, Rayyan QCRI Systematic Review software will be used. Selected full texts will be read independently by NFAR before final inclusion. The study selection process will be described using a PRISMA flow diagram. Quality of selected studies will be appraised by at least two coders using relevant Critical Appraisal Skills Programme (CASP) tool according to the types of study.

6. Procedure for extracting data

NFAR, JS, SNSM, and FI will independently extract data pertaining to all questions from the articles allocated individually. Any disagreements will be resolved by discussion or by consulting a third review author (SP/ ND). A standardised data extraction form will be developed and piloted before its use. Discussion on extracted data will be done to ensure rigour.

Data to be extracted and included in the 'characteristics of included studies' table are as listed below. Changes to the characteristics may occur during this review, as they serve only as a guide and some iteration and refinement of these procedures would be feasible given the complex field.

- Study author, year and country

- Characteristics of the medical school (if available) such as urban or rural, the ethos of each medical school
- Study aims
- Study design and method used for data collection
- Number and descriptions of participants
- Description of the clinical reasoning learning activities
- Conceptual framework (stated or inferred)
- Main findings
- Key conclusions
- Limitations
- Explicitly stated roles of stakeholders

7. Synthesis of extracted evidence

For the narrative synthesis a Meta-synthesis (Thomas and Harden). Meta-synthesis will be used as it is a suitable method to build up insights and to address the review questions. This review is contextual as its "goal is to identify the form and nature of what exists" with an additional aim of evaluating the reported facilitators and barriers to clinical reasoning teaching and learning in the undergraduate clinical education of primary care. The synthesis will use a mix of deductive or inductive processes. In the final stage, the transformative learning theory will be used as a lens to view data and mapped to the theory to develop a further in-depth understanding.

8. Scoping search

An initial scoping search using the key search terms of "clinical reasoning in medical education" in the PubMed database yielded 1583 articles of interest. With the help of the information specialist, a specific search strategy using a combination of expanded MESH terminologies and individual keyword resulted in 814 from a combination of databases i.e. EMBASE. MEDLINE and PsycINFO. Following deduplication, the numbers were reduced to 699 titles. Using keywords specific to patients-involvement for example, *patient-public involvement/participation, engagement, PPI* had led to only 6 titles. Discussion with SP and ND, resulted in the final key terminologies to exclude specific PPI related terminologies. Third scoping using the final consensus terminologies from MEDLINE yielded 313 titles. NFAR reviewed all the abstracts and

estimated that approximately 30% of full-text articles are relevant to the review questions. This number may double when other databases: MEDLINE, EMBASE, PsycINFO, CINAHL Plus and ERIC databases are included. It is acknowledged that using MeSH for clinical reasoning terminologies could be less than encompassing. Discussion with an expert in this research field has confirmed this. Effort to improve the limitation of clinical reasoning as a MeSH term is underway, unfortunately, this improvement will not affect articles published prior to 2021.

9. Translation into practice

This review will help practitioners to identify barriers and facilitators to clinical reasoning teaching and learning. It will potentially assist medical educators in implementing clinical reasoning teaching and learning within the context of experiential workplace-based primary health care settings. Medical faculties can use this review to write relevant policies to support students', stakeholders', and patients' roles in clinical reasoning education. This review may also produce new educational theory, particularly relating to the underlying range of theoretical framework used to underpin choice of clinical reasoning activities during taught and modelled by primary care teachers. It can also conceptualise patient's involvement specific to undergraduate clinical reasoning education in the primary care setting.

10. Project timetable

Review protocol	February 2020
Revised review protocol	December 2020
Data extraction	December 2020
Synthesis	March 2021
Systematic review article	June 2021

11. Conflict of interest statement

NFAR and FI received a Fundamental Research Grant Scheme no. FRGS/1/2019/SS06/USIM/02/2 related to patient and public involvement in medical education study from the Ministry of Education, Malaysia.

SP is a Co-Director of the London BEME International Collaboration Centre.

12. Plans to update the review

The review will be updated in 10 years or at any time if there is a significant disruption to how clinical reasoning learning and teaching is taught for medical programme in the future.

13. Changes to the protocol

Significant changes to this protocol in the future will be submitted to BEME for approval.

References

Ark, T. K., Brooks, L. R., & Eva, K. W. (2006). Giving learners the best of both worlds: Do clinical teachers need to guard against teaching pattern recognition to novices? *Academic Medicine*, *81*(4), 405–409. https://doi.org/10.1097/00001888-200604000-00017

Barber, J. R. G., Park, S. E., Jensen, K., Marshall, H., McDonald, P., McKinley, R. K., … Alberti, H. (2019). Facilitators and barriers to teaching undergraduate medical students in general practice. *Medical Education*, *53*(8), 778–787. https://doi.org/10.1111/medu.13882

Bösner, S., Pickert, J., & Stibane, T. (2015). Teaching differential diagnosis in primary care using an inverted classroom approach: student satisfaction and gain in skills and knowledge. *BMC Medical Education*, *15*(1), 63. https://doi.org/10.1186/s12909-015-0346-x

Braun, L. T., Zottmann, J. M., Adolf, C., Lottspeich, C., Then, C., Wirth, S., … Schmidmaier, R. (2017). Representation scaffolds improve diagnostic efficiency in medical students. *Medical Education*, *51*(11), 1118–1126. https://doi.org/10.1111/medu.13355

Brush, J. E., Sherbino, J., & Norman, G. R. (2017, June 1). How Expert Clinicians Intuitively Recognize a Medical Diagnosis. *American Journal of Medicine*, Vol. 130, pp. 629–634. https://doi.org/10.1016/j.amjmed.2017.01.045

Cave, J., Goldacre, M., Lambert, T., Woolf, K., Jones, A., & Dacre, J. (2007). *BMC Medical Education Newly qualified doctors' views about whether their medical school had trained them well: questionnaire surveys*. https://doi.org/10.1186/1472-6920-7-38

Considine, J., Botti, M., & Thomas, S. (2007). Do Knowledge and Experience Have Specific Roles in Triage Decision-making? *Academic Emergency Medicine*, *14*(8), 722–726. https://doi.org/10.1111/j.1553-2712.2007.tb01869.x

Dornan, T., Littlewood, S., Margolis, S. A., Scherpbier, A., Spencer, J., & Ypinazar, V. (2006, February). How can experience in clinical and community settings contribute to early

medical education? A BEME systematic review. *Medical Teacher*, Vol. 28, pp. 3–18. https://doi.org/10.1080/01421590500410971

Durning, S., Artino, A. R., Pangaro, L., van der Vleuten, C. P., & Schuwirth, L. (2011). Context and clinical reasoning: understanding the perspective of the expert's voice. *Medical Education*, *45*(9), 927–938. https://doi.org/10.1111/j.1365-2923.2011.04053.x

Durning, S. J. (2018). *Principles and Practice of Case-based Clinical Reasoning Education* (Vol. 15). https://doi.org/10.1007/978-3-319-64828-6

Gillespie, H., Kelly, M., Gormley, G., King, N., Gilliland, D., & Dornan, T. (2018). How can tomorrow's doctors be more caring? A phenomenological investigation. *Medical Education*, *52*(10), 1052–1063. https://doi.org/10.1111/medu.13684

Hege, I., Kononowicz, A. A., Kiesewetter, J., & Foster-Johnson, L. (2018). Uncovering the relation between clinical reasoning and diagnostic accuracy - An analysis of learner's clinical reasoning processes in virtual patients. *PLoS ONE*, *13*(10). https://doi.org/10.1371/journal.pone.0204900

Kiesewetter, J., Sailer, M., Jung, V. M., Schönberger, R., Bauer, E., Zottmann, J. M., … Fischer, M. R. (2020). *Learning clinical reasoning: how virtual patient case format and prior knowledge interact*. https://doi.org/10.1186/s12909-020-1987-y

Kopp, V., Stark, R., & Fischer, M. R. (2008). Fostering diagnostic knowledge through computer-supported, case-based worked examples: Effects of erroneous examples and feedback. *Medical Education*, *42*(8), 823–829. https://doi.org/10.1111/j.1365-2923.2008.03122.x

Lee, A., Joynt, G. M., Lee, A. K., Ho, A. M., Groves, M., Vlantis, A. C., … Aun, C. S. (2008). Using Illness Scripts to Teach Clinical Reasoning Skills to Medical Students. *Medical Student Education*, *42*(4), 255–261. Retrieved from http://www.stfm.org/fmhub/fm2010/April/Anna255.pdf

Lucey, C. R. (2013, September 23). Medical education: Part of the problem and part of the solution. *JAMA Internal Medicine*, Vol. 173, pp. 1639–1643. https://doi.org/10.1001/jamainternmed.2013.9074

Mezirow, J. (2003). Transformative Learning as Discourse. *Journal of Transformative Education*, *1*(1), 58–63. https://doi.org/10.1177/1541344603252172

Norman, G. (2005, April). Research in clinical reasoning: Past history and current trends. *Medical Education*, Vol. 39, pp. 418–427. https://doi.org/10.1111/j.1365-2929.2005.02127.x

Park, S., Khan, N. F., Hampshire, M., Knox, R., Malpass, A., Thomas, J., … Georgieva, Z. (2015). A BEME systematic review of UK undergraduate medical education in the general practice setting: BEME Guide No. 32. *Medical Teacher*, *37*(7), 611–630. https://doi.org/10.3109/0142159X.2015.1032918

Pelaccia, T., Plotnick, L. H., Audétat, M. C., Nendaz, M., Lubarsky, S., Torabi, N., … Dory, V. (2019). A Scoping Review of Physicians' Clinical Reasoning in Emergency Departments. *Annals of Emergency Medicine*. https://doi.org/10.1016/j.annemergmed.2019.06.023

Pelaccia, T., Tardif, J., Triby, E., Ammirati, C., Bertrand, C., Dory, V., & Charlin, B. (2016). From Context Comes Expertise: How Do Expert Emergency Physicians Use Their Know-Who to Make Decisions? *Annals of Emergency Medicine*, *67*(6), 747–751. https://doi.org/10.1016/j.annemergmed.2015.07.023

Rees, C. E., Knight, L. V., & Wilkinson, C. E. (2007). "User involvement is a sine qua non, almost, in medical education": Learning with rather than just about health and social care service users. *Advances in Health Sciences Education*, *12*(3), 359–390. https://doi.org/10.1007/s10459-006-9007-5

Ritchie, J. & Spencer, L. (1994). Analysing Qualitative Data. In R. G. [eds. . Bryman, A. and Burgess (Ed.), *Qualitative data analysis for applied policy research* (pp. 173–194). Retrieved from https://notts.rl.talis.com/items/8DE91E11-26D9-5610-0BEB-E8BA426C4DB4.html

Szumacher, E. (2019). Patients' Engagement in Medical Education. *Journal of Cancer Education*. https://doi.org/10.1007/s13187-019-01496-4

Towle, A. (2006). Where's the patient's voice in health professional education? *Nurse Education in Practice*, *6*(5), 300–302. https://doi.org/10.1016/j.nepr.2006.04.009

Young, M., Thomas, A., Lubarsky, S., Ballard, T., Gordon, D., Gruppen, L. D., … Durning, S. J. (2018). Drawing boundaries: The difficulty in defining clinical reasoning. *Academic Medicine*, Vol. 93. https://doi.org/10.1097/ACM.0000000000002142

Appendix A.

Participants/population	Medical education Undergraduate medical students Undergraduate medical education Clinical clerkship Preceptorship Clinical practicum
Intervention	Clinical reasoning Active reasoning Clinical decision making Clinical judgment Diagnostic reasoning Diagnosis, differential Diagnostic error Diagnostic knowing Diagnostic thinking Diagnostic problem solving Diagnostic verification Hypothetico-deductive reasoning Hypothesis generation Mental reasoning Therapeutic reasoning Problem-solving Dual-processing models System 1 thinking System 2 thinking Illness scripts Knowledge encapsulation Concept-mapping Clinical problem representation Problem-based learning/PBL Team-based learning/TBL
Context	Primary health care

	Community medicine General Practice Family medicine
Outcomes	1) Types of educational activities used for clinical reasoning 2) Theoretical framework described for the educational activities 3) Facilitators and barriers for clinical reasoning education 4) Students outcomes such as experiences of learning, doctoring identity development, knowledge/skills/attitude change 5) Stakeholder's role and influence on clinical reasoning education 6) Stakeholder's experiences, knowledge/skills/attitude change 7) Patient's role and experiences in clinical reasoning education 8) Patient's knowledge/attitude change

Appendix B – Search Strategy Example (based on MEDLINE)

1. Clinical Decision-Making/

2. Diagnosis, Differential/

3. Problem Solving/

4. Diagnostic Errors/

5. Concept Formation/

6. Problem-Based Learning/

7. Clinical reasoning.mp. [mp=title, abstract, original title, name of substance word, subject heading word, floating sub-heading word, keyword heading word, organism supplementary concept word, protocol supplementary concept word, rare disease supplementary concept word, unique identifier, synonyms]

8. Diagnostic reasoning.mp. [mp=title, abstract, original title, name of substance word, subject heading word, floating sub-heading word, keyword heading word, organism supplementary concept word, protocol supplementary concept word, rare disease supplementary concept word, unique identifier, synonyms]

9. therapeutic reasoning.mp. [mp=title, abstract, original title, name of substance word, subject heading word, floating sub-heading word, keyword heading word, organism supplementary concept word, protocol supplementary concept word, rare disease supplementary concept word, unique identifier, synonyms]

10. hypothesis generation.mp. [mp=title, abstract, original title, name of substance word, subject heading word, floating sub-heading word, keyword heading word, organism supplementary concept word, protocol supplementary concept word, rare disease supplementary concept word, unique identifier, synonyms]

11. hypothetico-deductive reasoning.mp. [mp=title, abstract, original title, name of substance word, subject heading word, floating sub-heading word, keyword heading

word, organism supplementary concept word, protocol supplementary concept word, rare disease supplementary concept word, unique identifier, synonyms]

12. differential diagnosis.mp. [mp=title, abstract, original title, name of substance word, subject heading word, floating sub-heading word, keyword heading word, organism supplementary concept word, protocol supplementary concept word, rare disease supplementary concept word, unique identifier, synonyms]

13. Clinical decision making.mp. [mp=title, abstract, original title, name of substance word, subject heading word, floating sub-heading word, keyword heading word, organism supplementary concept word, protocol supplementary concept word, rare disease supplementary concept word, unique identifier, synonyms]

14. symptom* assessment.mp. [mp=title, abstract, original title, name of substance word, subject heading word, floating sub-heading word, keyword heading word, organism supplementary concept word, protocol supplementary concept word, rare disease supplementary concept word, unique identifier, synonyms]

15. symptomatology.mp. [mp=title, abstract, original title, name of substance word, subject heading word, floating sub-heading word, keyword heading word, organism supplementary concept word, protocol supplementary concept word, rare disease supplementary concept word, unique identifier, synonyms]

16. illness script*.mp. [mp=title, abstract, original title, name of substance word, subject heading word, floating sub-heading word, keyword heading word, organism supplementary concept word, protocol supplementary concept word, rare disease supplementary concept word, unique identifier, synonyms]

17. student-patient communication.mp. [mp=title, abstract, original title, name of substance word, subject heading word, floating sub-heading word, keyword heading word, organism supplementary concept word, protocol supplementary concept word, rare disease supplementary concept word, unique identifier, synonyms]

18. problem-solving.mp. [mp=title, abstract, original title, name of substance word, subject heading word, floating sub-heading word, keyword heading word, organism

supplementary concept word, protocol supplementary concept word, rare disease supplementary concept word, unique identifier, synonyms]

19. clinical judgement.mp. [mp=title, abstract, original title, name of substance word, subject heading word, floating sub-heading word, keyword heading word, organism supplementary concept word, protocol supplementary concept word, rare disease supplementary concept word, unique identifier, synonyms]

20. diagnostic knowing.mp. [mp=title, abstract, original title, name of substance word, subject heading word, floating sub-heading word, keyword heading word, organism supplementary concept word, protocol supplementary concept word, rare disease supplementary concept word, unique identifier, synonyms]

21. mental reasoning.mp. [mp=title, abstract, original title, name of substance word, subject heading word, floating sub-heading word, keyword heading word, organism supplementary concept word, protocol supplementary concept word, rare disease supplementary concept word, unique identifier, synonyms]

22. diagnostic error*.mp. [mp=title, abstract, original title, name of substance word, subject heading word, floating sub-heading word, keyword heading word, organism supplementary concept word, protocol supplementary concept word, rare disease supplementary concept word, unique identifier, synonyms]

23. serial cue*.mp. [mp=title, abstract, original title, name of substance word, subject heading word, floating sub-heading word, keyword heading word, organism supplementary concept word, protocol supplementary concept word, rare disease supplementary concept word, unique identifier, synonyms]

24. knowledge encapsulation.mp. [mp=title, abstract, original title, name of substance word, subject heading word, floating sub-heading word, keyword heading word, organism supplementary concept word, protocol supplementary concept word, rare disease supplementary concept word, unique identifier, synonyms]

25. cognitive load.mp. [mp=title, abstract, original title, name of substance word, subject heading word, floating sub-heading word, keyword heading word, organism

supplementary concept word, protocol supplementary concept word, rare disease supplementary concept word, unique identifier, synonyms]

26. active reasoning.mp. [mp=title, abstract, original title, name of substance word, subject heading word, floating sub-heading word, keyword heading word, organism supplementary concept word, protocol supplementary concept word, rare disease supplementary concept word, unique identifier, synonyms]

27. concept map*.mp. [mp=title, abstract, original title, name of substance word, subject heading word, floating sub-heading word, keyword heading word, organism supplementary concept word, protocol supplementary concept word, rare disease supplementary concept word, unique identifier, synonyms]

28. cognitive schema*.mp. [mp=title, abstract, original title, name of substance word, subject heading word, floating sub-heading word, keyword heading word, organism supplementary concept word, protocol supplementary concept word, rare disease supplementary concept word, unique identifier, synonyms]

29. prototyp* network.mp. [mp=title, abstract, original title, name of substance word, subject heading word, floating sub-heading word, keyword heading word, organism supplementary concept word, protocol supplementary concept word, rare disease supplementary concept word, unique identifier, synonyms]

30. concept formation.mp. [mp=title, abstract, original title, name of substance word, subject heading word, floating sub-heading word, keyword heading word, organism supplementary concept word, protocol supplementary concept word, rare disease supplementary concept word, unique identifier, synonyms]

31. deliberate practice.mp. [mp=title, abstract, original title, name of substance word, subject heading word, floating sub-heading word, keyword heading word, organism supplementary concept word, protocol supplementary concept word, rare disease supplementary concept word, unique identifier, synonyms]

32. clinical vocabular*.mp. [mp=title, abstract, original title, name of substance word, subject heading word, floating sub-heading word, keyword heading word, organism

supplementary concept word, protocol supplementary concept word, rare disease supplementary concept word, unique identifier, synonyms]

33. clinical problem representation.mp. [mp=title, abstract, original title, name of substance word, subject heading word, floating sub-heading word, keyword heading word, organism supplementary concept word, protocol supplementary concept word, rare disease supplementary concept word, unique identifier, synonyms]

34. contrastive learning.mp. [mp=title, abstract, original title, name of substance word, subject heading word, floating sub-heading word, keyword heading word, organism supplementary concept word, protocol supplementary concept word, rare disease supplementary concept word, unique identifier, synonyms]

35. situated cognition.mp. [mp=title, abstract, original title, name of substance word, subject heading word, floating sub-heading word, keyword heading word, organism supplementary concept word, protocol supplementary concept word, rare disease supplementary concept word, unique identifier, synonyms]

36. problem-based learning.mp. [mp=title, abstract, original title, name of substance word, subject heading word, floating sub-heading word, keyword heading word, organism supplementary concept word, protocol supplementary concept word, rare disease supplementary concept word, unique identifier, synonyms]

37. PBL.mp. [mp=title, abstract, original title, name of substance word, subject heading word, floating sub-heading word, keyword heading word, organism supplementary concept word, protocol supplementary concept word, rare disease supplementary concept word, unique identifier, synonyms]

38. diagnostic thinking.mp. [mp=title, abstract, original title, name of substance word, subject heading word, floating sub-heading word, keyword heading word, organism supplementary concept word, protocol supplementary concept word, rare disease supplementary concept word, unique identifier, synonyms]

39. dual processing.mp. [mp=title, abstract, original title, name of substance word, subject heading word, floating sub-heading word, keyword heading word, organism

supplementary concept word, protocol supplementary concept word, rare disease supplementary concept word, unique identifier, synonyms]

40. dual process model.mp. [mp=title, abstract, original title, name of substance word, subject heading word, floating sub-heading word, keyword heading word, organism supplementary concept word, protocol supplementary concept word, rare disease supplementary concept word, unique identifier, synonyms]

41. system 1 thinking.mp. [mp=title, abstract, original title, name of substance word, subject heading word, floating sub-heading word, keyword heading word, organism supplementary concept word, protocol supplementary concept word, rare disease supplementary concept word, unique identifier, synonyms]

42. system 2 thinking.mp. [mp=title, abstract, original title, name of substance word, subject heading word, floating sub-heading word, keyword heading word, organism supplementary concept word, protocol supplementary concept word, rare disease supplementary concept word, unique identifier, synonyms]

43. semantic qualifier*.mp. [mp=title, abstract, original title, name of substance word, subject heading word, floating sub-heading word, keyword heading word, organism supplementary concept word, protocol supplementary concept word, rare disease supplementary concept word, unique identifier, synonyms]

44. diagnostic problem solving.mp. [mp=title, abstract, original title, name of substance word, subject heading word, floating sub-heading word, keyword heading word, organism supplementary concept word, protocol supplementary concept word, rare disease supplementary concept word, unique identifier, synonyms]

45. 1 or 2 or 3 or 4 or 5 or 6 or 7 or 8 or 9 or 10 or 11 or 12 or 13 or 14 or 15 or 16 or 17 or 18 or 19 or 20 or 21 or 22 or 23 or 24 or 25 or 26 or 27 or 28 or 29 or 30 or 31 or 32 or 33 or 34 or 35 or 36 or 37 or 38 or 39 or 40 or 41 or 42 or 43 or 44

46. Students, Medical/

47. Clinical Clerkship/

48. Education, Medical, Undergraduate/

49. Preceptorship/

50. Education, Medical/

51. medical student*.mp. [mp=title, abstract, original title, name of substance word, subject heading word, floating sub-heading word, keyword heading word, organism supplementary concept word, protocol supplementary concept word, rare disease supplementary concept word, unique identifier, synonyms]

52. clinical clerkship.mp. [mp=title, abstract, original title, name of substance word, subject heading word, floating sub-heading word, keyword heading word, organism supplementary concept word, protocol supplementary concept word, rare disease supplementary concept word, unique identifier, synonyms]

53. undergraduate medical education.mp. [mp=title, abstract, original title, name of substance word, subject heading word, floating sub-heading word, keyword heading word, organism supplementary concept word, protocol supplementary concept word, rare disease supplementary concept word, unique identifier, synonyms]

54. undergraduate medical student.mp. [mp=title, abstract, original title, name of substance word, subject heading word, floating sub-heading word, keyword heading word, organism supplementary concept word, protocol supplementary concept word, rare disease supplementary concept word, unique identifier, synonyms]

55. preceptorship.mp. [mp=title, abstract, original title, name of substance word, subject heading word, floating sub-heading word, keyword heading word, organism supplementary concept word, protocol supplementary concept word, rare disease supplementary concept word, unique identifier, synonyms]

56. clinical practicum.mp. [mp=title, abstract, original title, name of substance word, subject heading word, floating sub-heading word, keyword heading word, organism supplementary concept word, protocol supplementary concept word, rare disease supplementary concept word, unique identifier, synonyms]

57. medical education.mp. [mp=title, abstract, original title, name of substance word, subject heading word, floating sub-heading word, keyword heading word, organism supplementary concept word, protocol supplementary concept word, rare disease supplementary concept word, unique identifier, synonyms]

58. 46 or 47 or 48 or 49 or 50 or 51 or 52 or 53 or 54 or 55 or 56 or 57

59. Primary Health Care/

60. Community Medicine/

61. General Practice/

62. Family Practice/

63. primary health care.mp. [mp=title, abstract, original title, name of substance word, subject heading word, floating sub-heading word, keyword heading word, organism supplementary concept word, protocol supplementary concept word, rare disease supplementary concept word, unique identifier, synonyms]

64. primary healthcare.mp. [mp=title, abstract, original title, name of substance word, subject heading word, floating sub-heading word, keyword heading word, organism supplementary concept word, protocol supplementary concept word, rare disease supplementary concept word, unique identifier, synonyms]

65. primary care.mp. [mp=title, abstract, original title, name of substance word, subject heading word, floating sub-heading word, keyword heading word, organism supplementary concept word, protocol supplementary concept word, rare disease supplementary concept word, unique identifier, synonyms]

66. family medicine.mp. [mp=title, abstract, original title, name of substance word, subject heading word, floating sub-heading word, keyword heading word, organism supplementary concept word, protocol supplementary concept word, rare disease supplementary concept word, unique identifier, synonyms]

67. family practice.mp. [mp=title, abstract, original title, name of substance word, subject heading word, floating sub-heading word, keyword heading word, organism

supplementary concept word, protocol supplementary concept word, rare disease supplementary concept word, unique identifier, synonyms]

68. 59 or 60 or 61 or 62 or 63 or 64 or 65 or 66 or 67

69. 45 and 58 and 68

70. limit 69 to yr="2010 - 2020"